0073868

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

AUG 3 1 2007

07-AMCP-0273

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton
Richland, Washington 99354

Dear Ms. Hedges:

REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN FOR THE 200-PO-1 GROUNDWATER OPERABLE UNIT, DOE/RL-2007-31, DRAFT A AND TRI-PARTY AGREEMENT CHANGE PACKAGE M-15-07-04

The purpose of this letter is to transmit the Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit, DOE/RL-2007-31, Draft A to the State of Washington Department of Ecology for review and approval in accordance with Tri-Party Agreement Milestone M-013-10A. Please provide any review comments to the U.S. Department of Energy, Richland Operations Office by November 9, 2007.

Also attached is Tri-Party Agreement Change Package M-15-07-04 for your approval. This change package establishes a new Tri-Party Agreement Interim Milestone M-015-25C to allow for the gathering of additional groundwater well sampling and characterization information for the 200-PO-1 Operable Unit.

If you have any questions, please contact me, or your staff may contact Matt McCormick, Assistant Manager for the Central Plateau, on (509) 373-9971.

Sincerely,

Joe Franco for

David A. Brockman
Manager

AMCP:RDH

Attachments

cc: See Page 2

AUG 3 1 2007

cc w/attachs:
G. Bohnee, NPT
L. Buck, Wanapum
N. Ceto, EPA
L. J. Cusack, Ecology
R. H. Engelmann, EFSH
S. Harris, CTUIR
R. Jim, YN
S. L. Leckband, HAB
R. A. Lobos, EPA
K. Niles, ODOE
R. E. Piippo, FHI
J. G. Vance, FFS
Administrative Record 200-PO-1
Environmental Portal

Change Number M-15-07-04	**Federal Facility Agreement and Consent Order** ***Change Control Form*** Do not use blue ink. Type or print using black ink.	**Date** 7/24/2007

Originator Briant Charboneau **Phone** (509) 373-6137

Class of Change
[ ] I – Signatories [X] II – Executive Manager [ ] III – Project Manager

Change Title
Establishment of Hanford Federal Facility Agreement and Consent Order (Agreement) Interim Milestone M-015-25C

Description/Justification of Change

Approval of this change package authorizes;

1) Establish a new interim milestone for a Remedial Investigation (RI) Phase II Report for the 200-PO-1 Groundwater Operable Unit. The new interim milestone is being created to allow for the gathering of additional groundwater well sampling and characterization information for the 200-PO-1 OU.

Impact of Change
This change package clarifies scope and does not impact existing M-15 milestones.

Affected Documents
The Hanford Federal Facility Agreement and Consent Order, as amended and Hanford Site internal planning management, and budget documents (e.g., Baseline Change Control documents; related work authorizations and directives).

Approvals

_______________ _______ ____ Approved ____ Disapproved
Ecology Date

_______________ 8/30/07 X Approved ____ Disapproved
DOE-RL Date

_______________ _______ ____ Approved ____ Disapproved
EPA Date

(modifications to existing Tri-Party Agreement milestones are denoted with ~~strikeout~~; new milestone/text are denoted with shading.) :

Number	Title	Due Date
M-015-25C	Submit a Remedial Investigation (RI) Phase II Report for the 200-PO-1 Groundwater Operable Unit.	12/30/09

DOE/RL-2007-31
DRAFT A

Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

DOE/RL-2007-31
DRAFT A

Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit

Date Published
August 2007

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

J. D. Aardal 08/15/2007
Release Approval Date

EXECUTIVE SUMMARY

This Remedial Investigation/Feasibility (RI/FS) Study Work Plan for the 200-PO-1 Groundwater Operable Unit (200-PO-1 Groundwater OU) describes the approach for conducting the RI/FS to support selection of a remedial alternative. The approach includes data collection to support the RI/FS in both the "near-field" and "far-field" regions. The near-field region represents the source areas within and adjacent to the 200 East Area, and the downgradient areas to and including the Southeast Transect (a line of guard wells located southeast of the 200 East Area whose purpose is to ensure that unexpected contaminants do not migrate out of the 200 East Area undetected). The far-field region is defined as the area of the 200-PO-1 Groundwater OU extending from the Southeast Transect to the Columbia River. This Work Plan is based on the *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit* (FH 2007a). It assesses existing data needs in both near-field and far-field regions of 200-PO-1 Groundwater OU through the following:

- Identifying preferential flowpaths
- Identifying data gaps
- Evaluating the plume extents both vertically and horizontally
- Refining the geologic model.

The Data Quality Objective Summary Report provides background to support the development of a Characterization SAP and this Work Plan. The *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit* (DOE/RL 2005a), "Monitoring SAP" approved in 2005, supports *Resource Conservation and Recovery Act of 1976* (RCRA) and *Atomic Energy Act of 1954* requirements. In addition, to address data gaps and to support *Comprehensive Environmental Resource, Compensation, and Liability Act of 1980* (CERCLA), a supplementary *Sampling and Analysis Plan for Remedial Investigation and Characterization of the 200-PO-1 Groundwater Operable Unit* (DOE/RL 2007), "Characterization SAP," has been developed and is provided as Appendix A. This Work Plan uses the information from both documents to support the RI/FS process.

This Work Plan supports *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) (Tri-Party Agreement) Milestone M-013-10A. The Tri-Party Agreement provides for the integration of remedial actions under the CERCLA with corrective actions for treatment, storage, and/or disposal (TSD) units under RCRA. The TSD units that might have contributed to groundwater contamination at the 200-PO-1 Groundwater OU include the following RCRA TSD units: Plutonium-Uranium Extraction Plant (PUREX) Cribs (216-A-10 Crib, 216-A-36B Crib, and 216-A-37-1), A-AX Tank Farms, the 216-A-29 Ditch, 216-B-3 Pond system, and the Nonradioactive Dangerous Waste Landfill. The CERCLA sites that could have contributed to groundwater contamination at the 200-PO-1 Groundwater OU include 618-10 and 618-11 Burial Grounds within the 300-FF-5 Groundwater OU.

The strategy for the Data Quality Objective Summary Report and this Work Plan are summarized as follows.

- A list of contaminants of potential concern (COPC) was prepared based on historical information in the referenced literature and existing groundwater analysis data.

- A COPC generally was excluded from further consideration if it was not carcinogenic or toxic; if it was not mobile in soil; if it had a half life of less than 2 years; and had not been detected in groundwater above background; or there is no available human-health toxicity information (e.g., total organic carbon). Remaining contaminants were deemed to be COPCs.

- Preliminary target action levels, also known as preliminary remediation goals (PRG) were determined for COPCs. Both Federal and state standards were used to determine the PRGs. The PRGs were determined as the lower (more stringent) standard of either the U.S. Environmental Protection Agency's (EPA) maximum contaminant levels or the *Cleanup Levels & Risk Calculations (CLARC)* (Ecology 2005) database. If the contaminant background levels or detection limits were above the PRGs, the values were modified as appropriate. Some contaminants PRGs were unavailable and other applicable or relevant and appropriate requirements were used to determine appropriate PRGs.

- Historical groundwater data collected from wells in the 200-PO-1 Groundwater OU between 1988 and 2006 were compared to the PRGs. If a well historically had a particular analyte found above the PRG, the well will be monitored for that analyte.

A two-phased approach, as presented in Table ES-1, is planned to complete the RI activities for the 200-PO-1 Groundwater OU. In addition, the data gathered will be incorporated with already established geophysical and geotechnical information.

Table ES-1. Summary of Phase I and Phase II Characterization Activities.

<table>
<tr><th colspan="3">Phase I and Phase II</th></tr>
<tr><td>Characterization activities</td><td colspan="2">All wells and frequencies shown in Tables A3-1 and A3-2 of Appendix A</td></tr>
<tr><td>Routine monitoring activities</td><td colspan="2">All wells and frequencies shown in Tables 2-1 and 2-2 of Appendix B</td></tr>
<tr><th colspan="3">Phase I</th></tr>
<tr><td rowspan="7">Opportunistic Wells[b]</td><td>Area</td><td>Well identification[a]</td></tr>
<tr><td rowspan="3">PUREX</td><td>A-2</td></tr>
<tr><td>A-5</td></tr>
<tr><td>A-30</td></tr>
<tr><td rowspan="3">BC Cribs</td><td>A</td></tr>
<tr><td>C</td></tr>
<tr><td>E</td></tr>
<tr><td>Planned aquifer tubes</td><td>River Corridor</td><td>10 sets of 3</td></tr>
<tr><th colspan="3">Phase II</th></tr>
<tr><td></td><td>Area</td><td>Well identification[a]</td></tr>
<tr><td>Opportunistic wells[b]</td><td>PUREX</td><td>A-7</td></tr>
<tr><td rowspan="4">Planned wells[c]</td><td rowspan="4">To be decided</td><td>A</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td></tr>
<tr><td>D</td></tr>
</table>

[a]Preliminary well identification is presented. Once wells are physically established, formal well names will be given.
[b]Opportunistic wells are wells that operable units outside of the 200-PO-1 Groundwater Operable Unit are proposing to drill. These wells offer an opportunity for supplemental data gathering.
[c]Planned wells are those that may be drilled in the 200-PO-1 Groundwater Operable Unit, but locations will depend on the data evaluation from Phase I.

PUREX = Plutonium-Uranium Extraction (Plant or process).

Phase I and Phase II Activities

Samples from 107 wells and aquifer tubes will be assessed in the 200-PO-1 Groundwater OU during Phase I and Phase II. All samples from wells and aquifer tubes will be analyzed as shown in Tables A3-1 and A3-2 of Appendix A. Phase I and Phase II samples are to be taken as follows.

- Ten aquifer tubes will be installed along the river corridor. An aquifer tube consists of a set of three tubes emplaced at different depths vertically in one well casing.
- Opportunistic samples will be taken from six wells, three from the PUREX Area (A-2, A-5, and A-30) and three from the BC Crib and Trenches Area (A, C, and E) during Phase I. Opportunistic samples also will be taken from well A-7 during Phase II. Opportunistic wells are wells being drilled in other OUs from which the 200-PO-1 Groundwater OU task leads will acquire supplemental data.
- Four wells (A, B, C, and D) will be installed in the 200-PO-1 Groundwater OU during Phase II. The specific locations of these four new wells are to be determined after Phase I new and existing data are consolidated and analyzed.
- The remaining wells are existing wells that are to be added for assessment within the 200-PO-1 Groundwater OU.

Phase I

The primary objective of Phase I is to collect characterization data in both the near-field and far-field wells. Data collection will identify groundwater contaminants in the aquifer, acquire geophysical data to estimate vertical and lateral extent of contamination, and identify preferred contaminant pathways. In addition, a detailed evaluation of existing monitoring data will be conducted to assess data needs to determine preliminary fate and transport of analytes in the 200-PO-1 Groundwater OU. Ongoing monitoring as directed in the Monitoring SAP will continue, while the Characterization SAP will provide additional characterization of the 200-PO-1 Groundwater OU.

To accomplish the objectives of Phase I, ten aquifer tubes will be installed along the river corridor. In addition, six wells proposed by other OUs will be opportunistically sampled for 200-PO-1 Groundwater OU constituents in Phase I.

Eighty-six existing wells are to be assessed with the analytes and frequency of sampling shown in Tables A3-1 and A3-2 of the Characterization SAP (Appendix A). If a well is found to contain any COPCs over the target PRG, they will be evaluated and the existing sampling and analysis plan may be revised to ensure that potential future contaminant plumes are not missed. If the additional COPCs are not detected, they will not be considered further in the RI/FS study process. All of the new wells have been selected to undergo more extensive analysis of COPCs and modeling input parameters at various depths in the saturated zone to allow determination of the vertical extent of contamination. This provides information for use in computer models to predict plume size, migration rates, and other parameters of concern. The modeling input parameters include, for example, particle size, transmissivity, specific yield, specific storage, density, porosity, hydraulic data, pH, temperature, and depth measurements. The proposed sampling locations were selected with the goals of defining the vertical and horizontal plume boundaries and the locations, types, and amounts of contaminant concentrations.

Phase II

Up to four new wells will be installed in the 200-PO-1 Groundwater OU during Phase II. The locations of the new wells will be determined by data collected during Phase I. One well being installed near the 216-A-7 Crib will be opportunistically sampled. The primary objectives for Phase II are to evaluate Phase I results and other data, collect and evaluate additional data as they become available in order to accomplish Phase I objectives, and conduct a baseline risk assessment. To assist the decision-making process, the points of calculation that will be used when performing risk assessments will include points that represent the Columbia River, 200 East Area, 200 West Area, and the center of the largest groundwater contamination plume. A Record of Decision for the 200-PO-1 Groundwater OU will be issued at the conclusion of the RI/FS study process using the data collected in accordance with this Work Plan. It is anticipated that the scope of this project and to some extent any specific project plans are to be developed iteratively. As new information is acquired or new decisions are made, data requirements are to be reevaluated and, if appropriate, project plans will be modified.

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CONTENTS

APPENDICES

FIGURES

TABLES

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TERMS

200-PO-1 Groundwater OU	200-PO-1 Groundwater Operable Unit
AAMSR	aggregate area management study report
AEA	*Atomic Energy Act of 1954*
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CLARC	cleanup levels and risk calculations (Ecology, 2005)
CMS	corrective measures study
COPC	contaminant of potential concern
CRDL	contract-required detection limit
CSM	conceptual site model
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DQO	data quality objective
DST	double-shell tank
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERA	expedited response action
FY	fiscal year
HAB	Hanford Advisory Board
HEIS	*Hanford Environmental Information System* database
IDW	investigation-derived waste
IRIS	*Integrated Risk Information System*
IRM	interim remedial measure
K_a	abiotic hydrolysis degradation
K_d	distribution coefficient
K_h	hydraulic conductivity
LFI	limited field investigation
MCL	maximum contaminant level
MNA	monitored natural attenuation
N/A	not applicable
NRDWL	Nonradioactive Dangerous Waste Landfill
NTU	nephelometric turbidity unit
OU	operable unit
PC	potential contribution
pCi/L	picocuries/liter
PNNL	Pacific Northwest National Laboratory
ppb	parts per billion
ppm	parts per million
PUREX	Plutonium-Uranium Extraction (Plant or process)

QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RFI	RCRA facility investigation
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
SAC	System Assessment Capability
SALDS	state-approved land-disposal site
SAP	sampling and analysis plan
SIM	*Hanford Soil Inventory Model, Rev. 1* (RPP-26744) (CHG 2005)
SST	single-shell tank
TEDF	Treated Effluent Disposal Facility
TPA	Tri-Party Agreement
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)
TSD	treatment, storage, and/or disposal
VOC	volatile organic compound
VZ	vadose zone
WIDS	*Waste Information Database System* database
WAC	*Washington Administrative Code*
XRD	X-ray diffraction

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.453	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

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1.0 INTRODUCTION

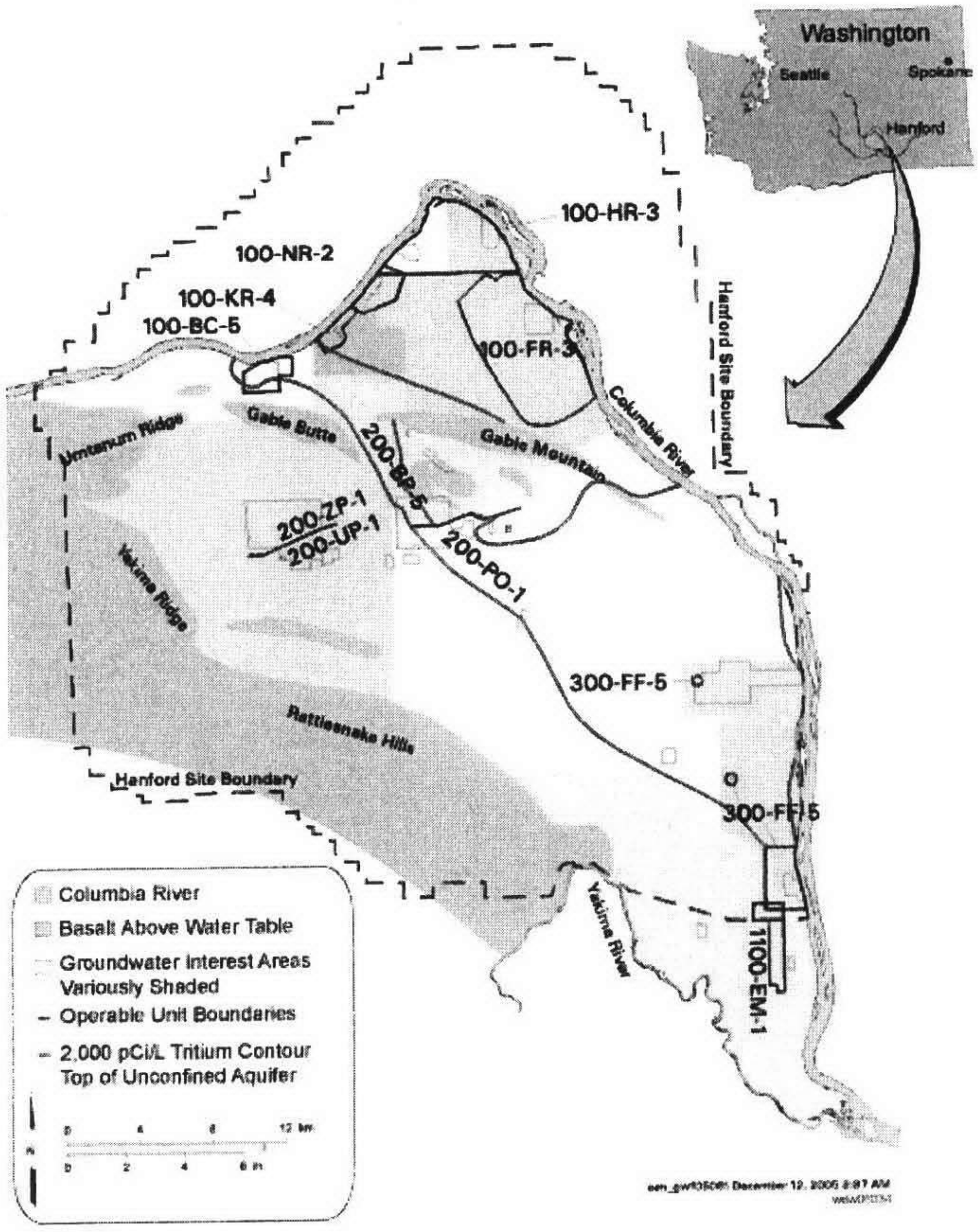
This Remedial Investigation/Feasibility Study (RI/FS) Work Plan for the 200-PO-1 Groundwater Operable Unit (200-PO-1 Groundwater OU) describes the 200-PO-1 Groundwater OU setting and establishes the objectives, tasks, and schedule for conducting a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) RI/FS. As agreed upon by the U.S. Department of Energy (DOE), Richland Operations Office (RL), and the U.S. Environmental Protection Agency (EPA), this Work Plan also supports the final remedy selection for the 200-PO-1 Groundwater OU. Ongoing groundwater monitoring activities and RI/FS characterization are consolidated in this Work Plan along with associated sampling and analysis plans (SAP). The *Sampling and Analysis Plan for Remedial Investigation and Characterization of the 200-PO-1 Groundwater Operable Unit* (DOE/RL 2007), "Characterization SAP," is included as Appendix A. The "Routine Monitoring SAP" (approved in 2005), *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit* (DOE/RL 2005a), "Monitoring SAP," is provided for completeness and informational purposes electronically per the web address provided in Appendix B. Data generated from the Characterization and Monitoring SAPs will be used in the RI/FS. The activities conducted under this Work Plan will conform to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989) as amended and signed by the Washington State Department of Ecology (Ecology), EPA, and RL. This Work Plan is in support of Tri-Party Agreement Milestone M-013-10A.

Figure 1-1 shows the location of the 200-PO-1 Groundwater OU at the Hanford Site. Plate maps included in Appendix C show existing monitoring wells (see the Monitoring SAP in Appendix B) and contaminant plume extents as presented in *Hanford Site Groundwater Monitoring for Fiscal Year 2006* (Annual Monitoring Report) (PNNL 2007), locations of proposed characterization wells (see Characterization SAP in Appendix A), and additional opportunistic sample locations (see Section 4.3.1). The 200-PO-1 Groundwater OU underlies the Plutonium-Uranium Extraction Plant (PUREX) and B Plant aggregate areas, and includes PUREX; the Nonradioactive Dangerous Waste Landfill (NRDWL); the A-AX Tank Farm; and various ponds, cribs, and trenches.

Although this Work Plan does not directly address vadose zone (VZ) concerns within the 200-PO-1 Groundwater OU, VZ data are used as input to groundwater modeling and risk assessment activities that are components of the RI/FS process. The Waste Site Remediation Project and Tank Farms Project address the potential groundwater impact of VZ contamination from *Resource Conservation and Recovery Act of 1976* (RCRA) waste sites. The Waste Site Remediation Project is scheduled to complete waste site remediation activities in the vicinity of the PUREX Plant by 2017.

This Work Plan does not address compliance issues for RCRA treatment, storage, and/or disposal (TSD) units within the 200-PO-1 Groundwater OU. Contaminants from some TSD units are impacting groundwater in the 200-PO-1 Groundwater OU (*200-PO-1 Operable Unit Permit Modification* [DOE/RL 1996a]). The history and contaminant of potential concern (COPC) impacts of the 200-PO-1 Groundwater OU TSD units are included in this Work Plan because groundwater will be remediated under CERCLA. The RCRA sites will be evaluated for impact to groundwater in the 200-PO-1 Groundwater OU when data are available. Closure information for the RCRA sites is presented in the *Optimization Strategy for Central Plateau Closure* (FH 2003a). In accordance with the Tri-Party Agreement, all 200 Area non-tank-farm OUs must be closed by 2024.

Figure 1-1. Location of the 200-PO-1 Groundwater Operable Unit at the Hanford Site (PNNL 2007).



Background and physical setting information, and conceptual models are discussed in other project documents and are not addressed in detail in this Work Plan. Previously documented information is summarized in Chapter 2.0.

1.1 PURPOSE, SCOPE, AND OBJECTIVES

The purpose of this Work Plan is to describe the approach for completing the RI/FS to support selection of a final remedy for the 200-PO-1 Groundwater OU. The project scope is to better define the nature and extent of contamination in the 200-PO-1 Groundwater OU to support risk assessment and screening of remedial alternatives. Site-specific treatability studies are not included in the project scope because none are currently expected. The project's objective is to collect sufficient data to support the associated risk assessment, and allow the ultimate selection of one or more appropriate remedial alternatives.

EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006) provides the guidance for identifying data requirements. The EPA and RL participated in a data quality objective (DQO) process for the 200-PO-1 Groundwater OU and generally concurred with the results. Both EPA and RL agreed that this Work Plan may require updating as additional relevant VZ and RCRA facility information is obtained.

1.2 PROJECT GOALS

The primary goal of the investigations described throughout this Work Plan is to identify and provide remaining data that are needed to complete groundwater modeling and risk assessment activities for supporting a final remedy selection. The approach for these investigations is to examine existing well data, and determine whether additional data are required from either existing or new monitoring wells that are identified in the *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Groundwater Monitoring Network* (FH 2003b).

1.3 DOCUMENT ORGANIZATION

This Work Plan contains eight chapters and five appendices. The body of the document consists of the following chapters:

- 1.0 Introduction
- 2.0 Site Setting and Background
- 3.0 Summary of Historical Investigations
- 4.0 Work Plan Rationale and Saturated Zone Characterization
- 5.0 Remedial Investigation Tasks
- 6.0 Feasibility Study
- 7.0 Project Schedule and Key Assumptions
- 8.0 References.

Appendix A is the Characterization SAP, which focuses on the approach for characterization of the 200-PO-1 Groundwater OU. Appendix B (provided for informational purposes by electronic reference) is a routine groundwater Monitoring SAP that was approved in 2005. The Monitoring SAP focuses on quality assurance (QA), field sampling plans, and other details regarding QA and quality control (QC) requirements for data collection and evaluation. Appendices C, D, and E contain plate maps, a bibliography, and an evaluation of COPCs based on historical groundwater data, respectively.

The QA plans that are described in Appendices A and B are commonly applied at the Hanford Site. Many of the referenced documents were reviewed for previous Hanford Site reports, and are available upon request. The QA system meets EPA guidelines for format and structure (*EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* [EPA 2001]). Data collection and analysis methods are based on two documents that are accepted by EPA and RL: *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846), as amended (EPA 2005), and *Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL 1998).

This Work Plan summarizes existing data that are described in more detail elsewhere, and references the applicable documents. Information is placed in one location and cross-referenced where possible to minimize redundancy and facilitate future updates.

2.0 SITE SETTING AND BACKGROUND

This chapter provides a general description, history of operations, and potential sources of contamination for the 200-PO-1 Groundwater OU.

2.1 200-PO-1 GROUNDWATER OPERABLE UNIT PHYSICAL SETTING

The 200-PO-1 Groundwater OU is located in the 200 East Area of the Hanford Site as shown in Figure 1-1. An ongoing investigation will define the boundaries that are applicable for future RI/FS activities. Currently, two different boundaries sets are used for the 200-PO-1 Groundwater OU. One of the currently applied boundaries is geographically defined; the other boundary includes a 2,000 picocuries/liter (pCi/L) isopleth for a groundwater tritium plume in the southeast portion of the unconfined aquifer within the 200-PO-1 Groundwater OU. The associated tritium groundwater plume extends eastward and southward from potential contaminant sources in the southern portion of the 200 East Area. The geographic boundaries of the 200-PO-1 Groundwater OU are the Columbia River to the east, the 300-FF-5 Groundwater OU to the south, and the 200-BP-5 Groundwater OU to the north. Figure 4-1 presents the OU boundaries.

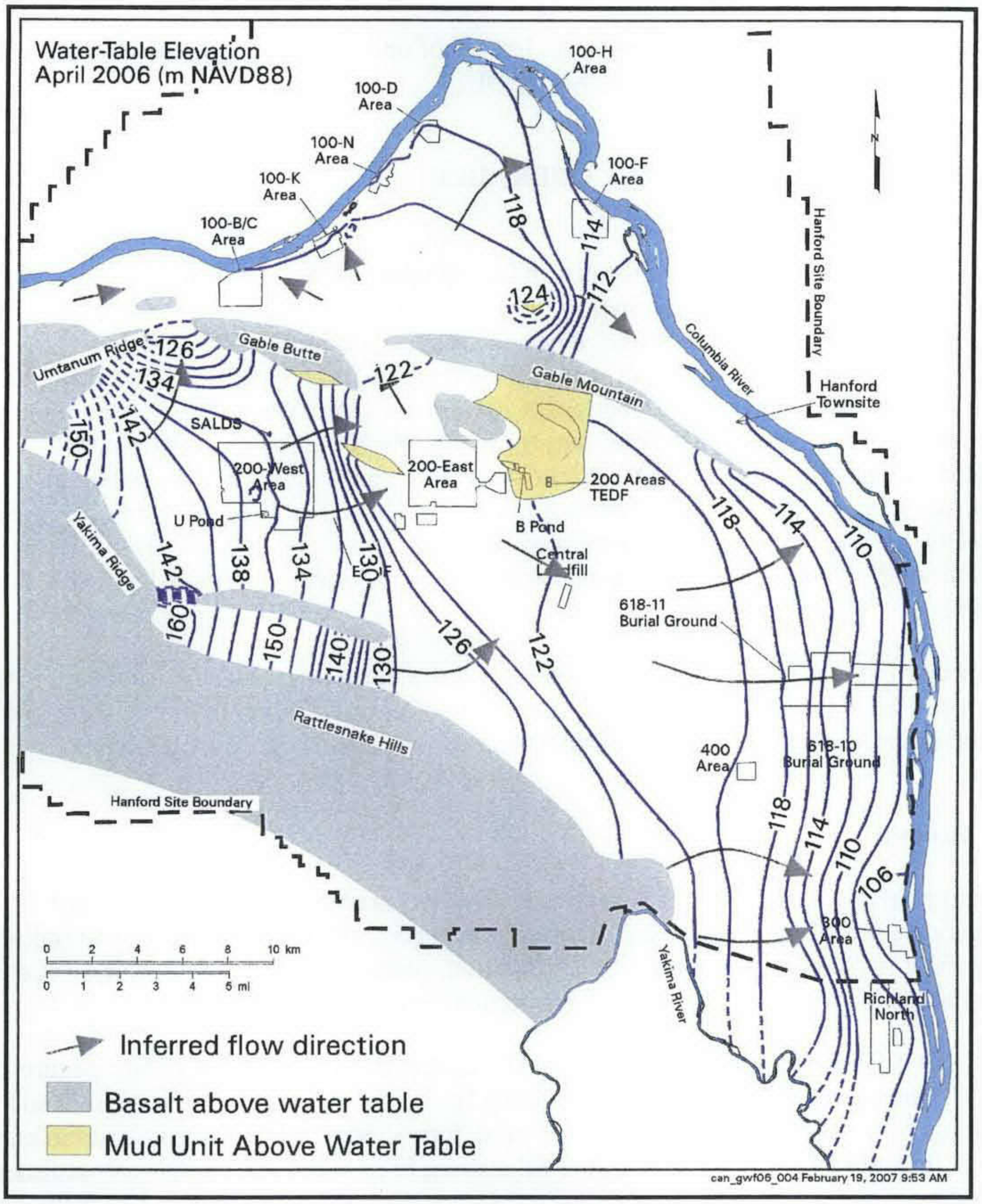
Groundwater in the unconfined aquifer generally flows north toward Gable Mountain in the northern 200 East Area, and southeasterly toward the Columbia River in the southern portion. The 2006 inferred groundwater flow patterns beneath the Hanford Site are shown in Figure 2-1.

2.1.1 Geology

The geology of the Hanford Site has been extensively characterized as a result of past investigations, including regional and Hanford Site surface mapping, borehole/well sediment logging, field and laboratory sediment classification, surface and borehole geophysical studies, and in situ and laboratory hydrogeologic properties testing.

The 200-PO-1 Groundwater OU is located in the central part of the Pasco Basin. Figure 2-2 presents a generalized geologic map of the Pasco Basin, showing the broad structural and topographic basin that was formed by structural deformation of thick sequences of tholeiitic flood basalts, intercalated sediments of the Ellensburg Formation, and suprabasalt sediments. The basalts of the Columbia River Basalt Group were extruded between 6 and 17 million years ago. Unconsolidated and partly consolidated sediments of the Miocene through Pleistocene age overlie the basalts (*RCRA Facility Investigation Report for the 200-PO-1 Operable Unit* [DOE/RL 1997a]). Figure 2-3 presents a conceptual hydrogeologic column of the Hanford Site.

Figure 2-1. Inferred Groundwater Flow Patterns Beneath the Hanford Site (PNNL 2007).



This map shows the water table and inferred flow directions in April 2006. Areas shaded in gray or tan show where the unconfined aquifer is absent.

Figure 2-2. Generalized Geologic Map of the Hanford Site.

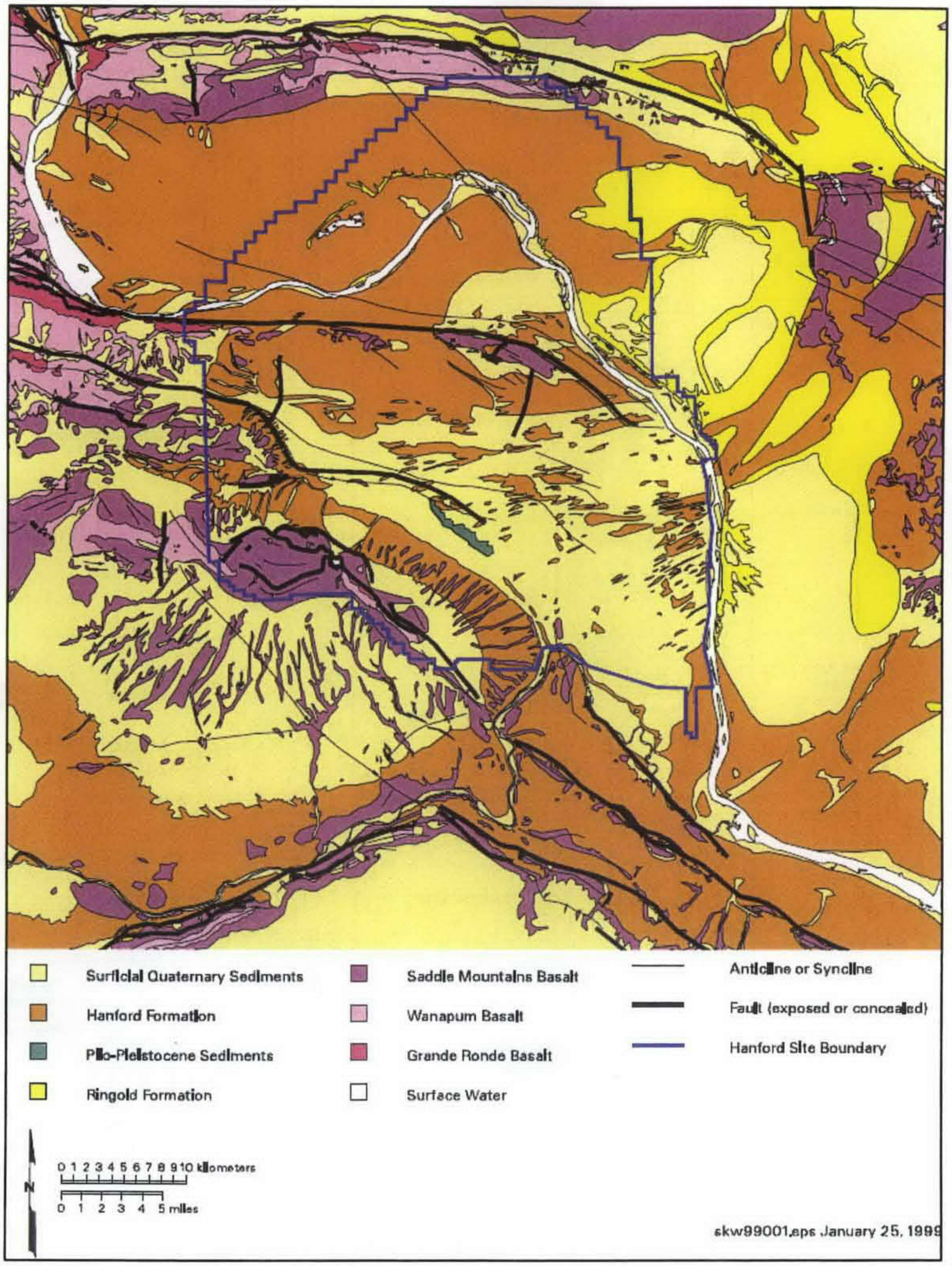
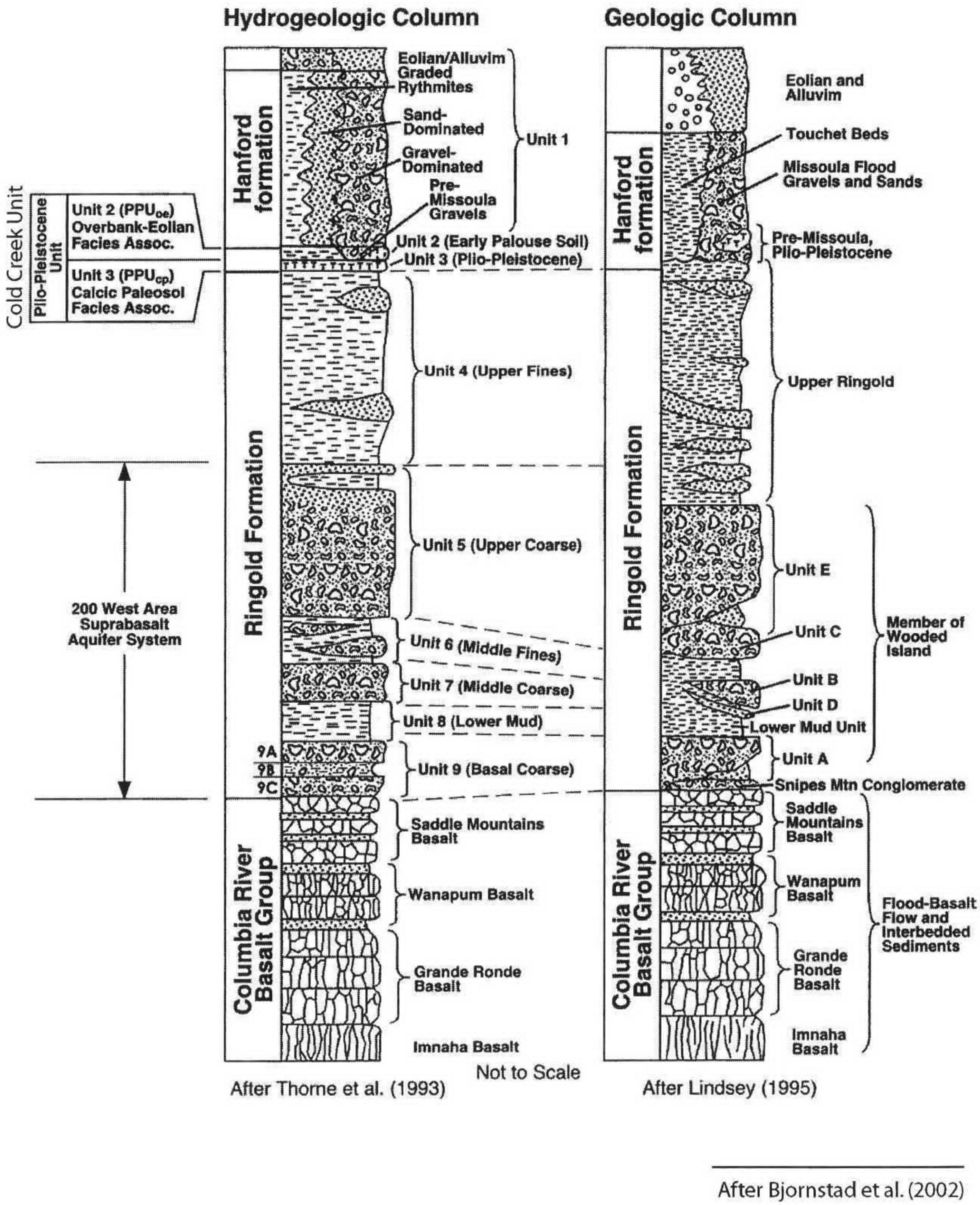


Figure 2-3. Conceptual Hydrogeologic Column for the Hanford Site.



The basalt flows of the Columbia River Basalt Group were extruded during Miocene time from vents in southeastern Washington, northern Oregon, and western Idaho. Beneath the 200-PO-1 Groundwater OU, the youngest and uppermost basalts present are members of the Saddle Mountains Basalt Formation of the Columbia River Basalt Group (*Geologic Studies of the Columbia Plateau: A Status Report* [Myers et al., 1979]). The Saddle Mountains Basalt is divided into the Ice Harbor, Elephant Mountain, Pomona, Esquatzel, Asotin, Wilbur Creek, and Umatilla Members (refer to Figure 2-4). The Elephant Mountain Member is the upper most basalt unit and is approximately 35 m (115 ft) thick beneath most of the Hanford Site except in the vicinity of the 300 Area, where the overlying Ice Harbor Member is encountered, and is the uppermost confining layer beneath the 200-PO-1 Groundwater OU. Beneath most, if not all of the 200-PO-1 Groundwater OU, the Rattlesnake Ridge interbed comprises the uppermost confined aquifer.

The geology of the suprabasalt sediments are well-defined in the 200 East Area and NRDWL due to a large number and closely spaced wells. A lesser degree of confidence exists in the region east of the 200 Areas and NRDWL and north of the 300 Area, due to wide spacing and shallow depths of most boreholes. The suprabasalt sediments beneath the 200-PO-1 Groundwater OU are dominated by extensive deposits assigned to the Miocene to Pliocene-aged Ringold Formation. The suprabasalt sedimentary sequence ranges up to 215 m (700 ft) thick and contains the uppermost-unconfined aquifer.

The typical lithology of the 200-PO-1 Groundwater OU consists of intervals that generally grade form fine to coarse sediments as depth increases in the VZ including major fine-grained intervals, and laterally persistent coarse-grained sequences (DOE/RL 1997a). The distribution of facies types and similarities in the lithologic succession across the 200 East Area indicates that the Hanford Formation can be divided into three stratigraphic intervals which are designated as (1) lower gravel, (2) sand, and (3) upper gravel. Each stratigraphic level is dominated by deposits typical of their sequences; e.g., upper and lower gravel sequences are dominated by deposits typical of gravel facies.

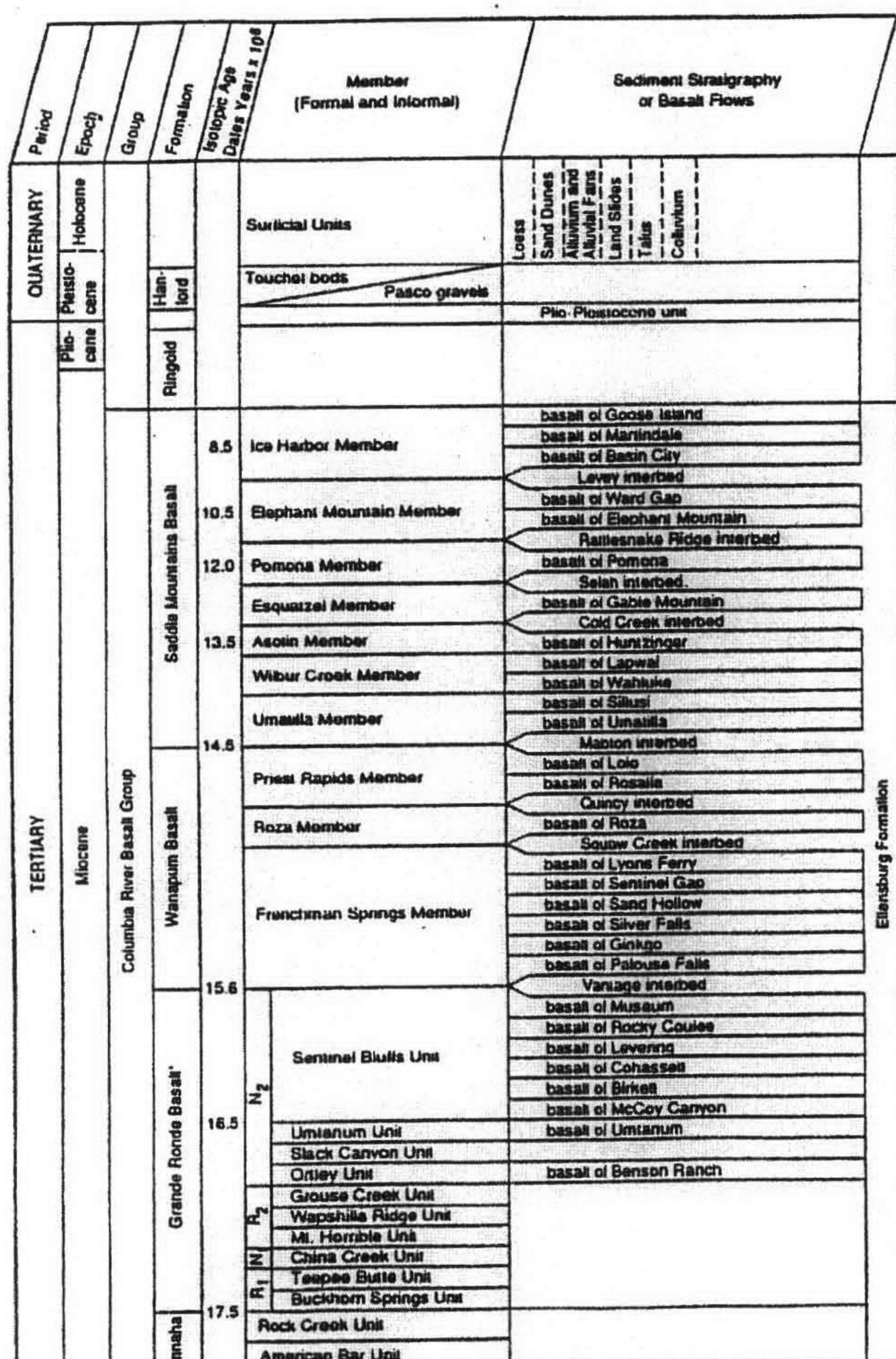
Surficial deposits in the 200 East Area are dominated by very fine- to medium-grained, and occasionally silty, eolian sheet sands. These deposits were removed from much of the area by construction activities.

2.1.2 Hydrology

This section describes the hydrostratigraphic and groundwater flow characteristics of the basalt aquifers, unconfined aquifer, and VZ sediments in the 200-PO-1 Groundwater OU. The uppermost aquifer beneath most of the Hanford Site is generally unconfined within the sands and gravels that overlie the basalt bedrock. In some areas, layers of silt and clay confine portions of the aquifer. Confined aquifers occur within the basalt flows and sedimentary interbeds. Groundwater beneath the Hanford Site flows primarily from recharge areas along the western parts of the site, to the east and north towards the Columbia River. Groundwater flow patterns were modified by groundwater mounds caused by the discharge of large volumes of process water from Hanford Site activities. Because discharges no longer occur at the waste sites, groundwater flow patterns and gradients are reverting to "pre-Hanford" conditions

(DOE/RL 1997a). Subsequently, the water table in the 200 East Area has a low gradient, causing a fairly flat water table that makes interpretations of groundwater flow directions difficult. Beginning in 2002, the rate of water table decline in the 200 East Area and vicinity slowed significantly. Permitted effluent releases to the 200 Areas Treated Effluent Disposal Facility (TEDF) were a factor in the observed water table fluctuation (PNNL 2007).

Figure 2-4. Generalized Stratigraphy of the Hanford Site.



*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named.
N_2, R_2, N_1 and R_1 are magnetostratigraphic units.

H9103029.6

2.1.2.1 200 East Area Hydrostratigraphy

The primary hydrostratigraphic units in the 200 East Area are (1) the Rattlesnake Ridge interbed and deeper interbeds of the Ellensburg Formation (confined water-bearing zones); (2) the Elephant Mountain Member and deeper lava flows of the Saddle Mountains Basalt (confining horizons with local interflow zones); (3) Ringold Formation sediments (locally semi-confined to confined water-bearing zones in unit A gravels beneath the lower mud sequence, and unconfined aquifer in unit A and unit E gravels); (4) the Hanford Formation (unconfined aquifer and VZ sediments).

2.1.2.1.1 Basalt Aquifers

Several regional confined aquifers exist within the Saddle Mountains Basalt-Ellensburg Formation hydrostratigraphic unit in the 200-PO-1 Groundwater OU. The confined water-bearing zones occur in the interbeds of the Ellensburg Formation and in interflow and fractured intraflow zones within the basalts. The uppermost regional confined aquifer in the vicinity is generally within the Rattlesnake interbed of the Ellensburg Formation, but includes the fractured flow top and bottom of the enclosing basalt flows. The upper confining unit, the Elephant Mountain Member, has been locally removed by erosion north of the 200 East Area, although there is no evidence of erosion in the 200-PO-1 Groundwater OU. The Elephant Mountain aquifer merges with the unconfined aquifer in the northeast corner of the 200 East Area (DOE/RL 1997a).

2.1.2.1.2 Uppermost Aquifer System

The uppermost aquifer system in the 200-PO-1 Groundwater OU is primarily unconfined but includes localized semi-confined and confined areas (see Figure 2-1). The base of the unconfined aquifer throughout the majority of the 200-PO-1 Groundwater OU is the Ringold lower mud unit except where the unit is absent in the northern and central portions of the 200 East Area. The thickness of the uppermost aquifer ranges from near zero in the northeastern portions of the 200-PO-1 Groundwater OU, where basalt bedrock extends above the water table, to more than 137 m (450 ft) at NRDWL. The water levels in the wells penetrating the lower mud unit are generally positioned at the top of the lower mud.

2.1.2.1.3 Aquifer Intercommunication

Throughout most of the 200-PO-1 Groundwater OU, groundwater in the uppermost aquifer system (including the upper portions of the Ringold Formation and overlying Hanford formation) is isolated from groundwater in the confined Ringold Formation system and lower basalt aquifers by the Ringold Formation lower mud unit (unit 8). Hydraulic head below the lower mud unit is usually slightly higher than the unconfined aquifer system above the lower mud unit creating an upward gradient or the potential for upward groundwater flow. For instance, PUREX well characterization data in 1997 measured the confined Ringold Formation unit A potentiometric head measurement approximately 4 ft higher than the head in the sediments above the lower mud unit in well 699-37-47A (*Borehole Data Package for Well 699-37-47A, PUREX Plant Cribs, CY 1996* [PNNL 1996]), which is located near the southeast corner of the 200 East Area. An erosional window exists between the lower confined aquifer system and uppermost aquifer system along the margins of the buried paleo-channel that runs northwest to southeast across the northern half of the 200 East Area. This paleo-channel cuts through part to all of the Ringold Formation thickness allowing the lower portions of the Ringold Formation (unit 9) to come into direct contact with the overlying Hanford formation sediments (unit 1). Because the hydraulic conductivity of the Hanford formation sediments in the channel fill is generally higher than that of Ringold Formation unit A, and there is an upward gradient throughout most of the 200-PO-1 Groundwater OU, groundwater from the confined or partially confined Ringold Formation (unit A) likely discharges into the highly-transmissive channel-fill sediments where it mixes with groundwater of the uppermost aquifer system.

2.2 HISTORY OF OPERATIONS AND GROUNDWATER CONTAMINANT SOURCES

Numerous sources of liquid waste discharge have existed in the 200 Areas since the inception of activities on the Hanford Site in 1945. Operations in the 200 Areas were related to the chemical separation of plutonium from spent nuclear fuel. Operations in the PUREX Plant, B Plant, and U Plant resulted in liquid disposal to the soil column in the OU area, which contaminated the underlying groundwater. Waste streams included steam condensate, process cooling water, chemical sewer waste, and acid fractionator condensate (DOE/RL 1997a). Radioactive waste, such as cooling water condensate, was disposed to open trenches and ponds and later flushed with fresh water. Process waste batches were disposed to cribs. Radioactive wastes that were a result of either exposure to radioactive fuel or reprocessing of reactor fuel were directed to single-shell tanks. Some tanks have leaked, or have been associated with unplanned releases.

Summaries of historical operations and disposal practices for PUREX and B Plants are presented in the following subsections. Detailed information on discharges to these units can be found in aggregate area management study reports (AAMSR) (*PUREX Plant Source Aggregate Area Management Study Report* [DOE/RL 1993a] and *B Plant Source Aggregate Area Management Study Report* [DOE/RL 1993b]). Documents providing additional historical information are discussed in Chapter 3.0. The documents presented in this section provide background on historic data. For newer data, Section 4.2 presents an evaluation of analytical data from sampling activities in the 200-PO-1 Groundwater OU.

In 1993, the AAMSRs provided significant characterization information that supported the preparation of the 200-PO-1 Groundwater OU remedial field investigation (RFI) and corrective measures study (CMS). In 1996, waste sites overlying the 200 Area groundwater OUs were grouped into process-based OUs that continue to be investigated. These investigations are not within the 200-PO-1 Groundwater OU project scope but provide valuable data on contaminants that may impact the 200-PO-1 Groundwater OU groundwater.

2.2.1 Origins of Waste: Historical Operations, Disposal Practices, and Waste Management Units

The Hanford Site, established in 1943, originally was designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants.

During 1943 and 1944, three reactors (B, D, and F) were constructed on the Hanford Site. In addition, three processing facilities (B, T, and U Plants) were built. After World War II, six more reactors were built (H, DR, C, KW, KE, and N Reactors). Beginning in the 1950s, energy research and development, isotope use, and other activities were added to Hanford Site operations. A gradual shutdown of the Hanford Site reactors began in 1964. Eight reactors were no longer operating in 1971. The N Reactor operated through 1987 and was placed on cold standby status in October 1989.

Operations in the 200 Areas (East and West) mainly were related to separation of special nuclear materials from spent nuclear fuel. The 200 East Area consists of two main processing facilities: the PUREX Plant and the B Plant.

2.2.1.1 PUREX Plant

The PUREX Plant aggregate area, which overlies the northern portion of the 200-PO-1 Groundwater OU, contains a variety of facilities that were involved in waste generation, transfer, treatment, storage, or disposal. The locations of plants, buildings, and waste sites in the PUREX aggregate area are shown in Figure 2-5. Waste sites shown in green are definite source areas of contamination. Radiologically contaminated processing wastes were discharged to the soil column through cribs, trenches, and other facilities. Wastes that were not normally contaminated, but have the potential to contain radionuclides, such as cooling and condensate water, were allowed to infiltrate the subsurface through ponds and open ditches.

The PUREX Plant was constructed between 1953 and 1955, operating as a chemical separation facility until 1972. This facility was one of the primary sources of waste in the PUREX aggregate area and is the dominant physical structure within the 200-PO-1 Groundwater OU. During operation, the PUREX process used tributyl phosphate in normal paraffin hydrocarbon solvent to recover uranium and plutonium from irradiated fuel rods dissolved in nitric acid solutions. Lower activity radioactive PUREX waste was disposed to liquid waste disposal units such as cribs (e.g., 216-A-36B, 216-A-10, 216-A-37-1, and 216-A-45), trenches, and french drains, while the highly radioactive waste was diverted to the tank farms. Wastes were disposed of directly to the soil in 23 cribs, 4 trenches, and 15 french drains. Several unplanned releases are located in the vicinity of the PUREX Plant. These unplanned releases range from contaminated tumbleweeds to leaks in a diversion box.

2.2.1.2 B Plant

The B Plant aggregate area, which is beyond the northern boundary of the 200-PO-1 Groundwater OU, contains a large variety of waste disposal and storage facilities. The locations of plants, buildings, and waste sites in the B Plant aggregate area are shown in Figure 2-6. Waste sites shown in green represent sites that are definite source areas of contamination, while the purple sites are possible sources. Highly radioactive process wastes were stored in underground single-shell tanks. Less radioactive wastes, such as cooling and condensate water, were allowed to infiltrate the subsurface through cribs, trenches, reverse wells, and open ponds.

Figure 2-5. Locations of Plants, Buildings, and Waste Sites in the Plutonium-Uranium Extraction Plant Aggregate Area.

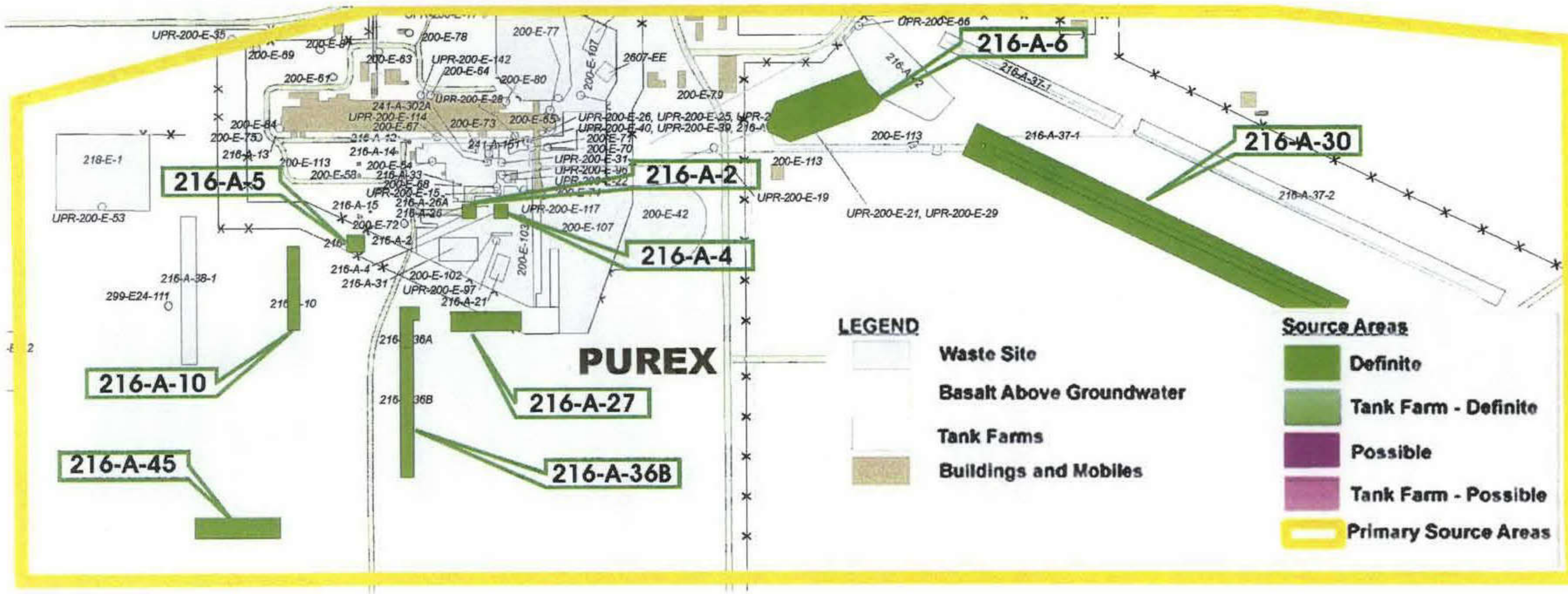
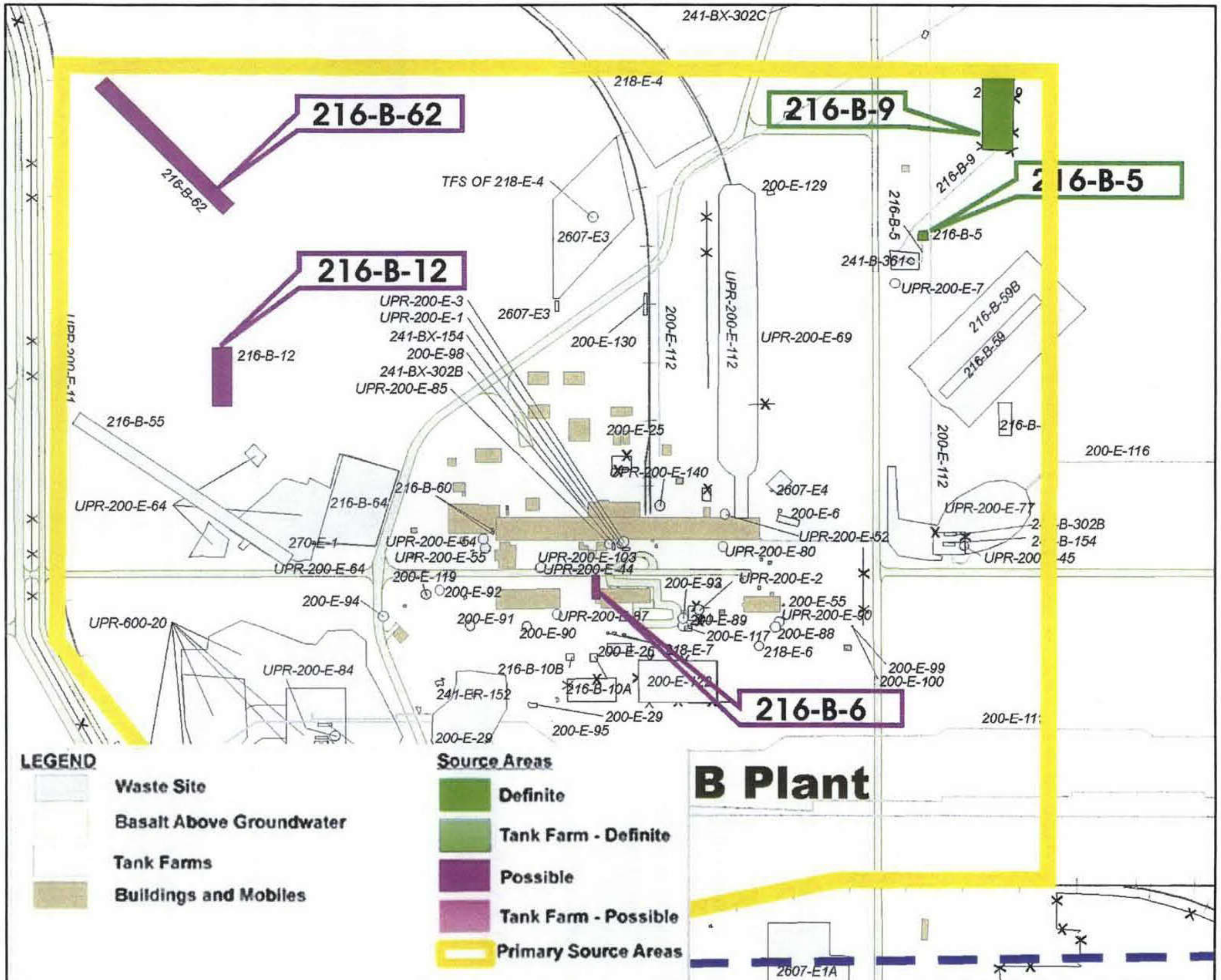


Figure 2-6. Locations of Plants, Buildings, and Waste Sites in the B Plant Aggregate Area.



The B Plant used a bismuth phosphate process to extract plutonium from irradiated fuel rods from 1945 to 1952. From 1968 to 1985, the plant was used to recover cesium and strontium from tank farm waste. Process cooling water and steam condensate from the B Plant was sent to the 216-B-3 Pond Complex (B Pond). The larger volumes of wastewater discharged to the B Pond are known to have affected both the northward and southward groundwater flow regimes in the 200 East Area. Impacts on the 200-PO-1 Groundwater OU from B Plant activities primarily are related to the 216-B-3 Pond System (B Ponds and ditches). The B Ponds began receiving liquid waste in 1945. Three lobes (A, B, and C) were added in the 1980s. Significant groundwater mounding occurred below the B Ponds resulting in alterations in groundwater flow in the 200 East Area. Groundwater mounding has receded since the 216-B-3B lobe was deactivated in 1985. Only the main lobe and a portion of the 216-B-3 Ditch are currently regulated, while other portions were deactivated, backfilled, and "clean closed" in 1994 (*Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility* [PNNL 2005a]).

2.2.1.3 U Plant

Wastewater from the U Plant (in the 200 West Area) was transported to the 200 East Area through underground pipelines. The plant used tributyl phosphate in kerosene diluent to recover uranium metal from the bismuth phosphate process waste stored in the tank farms. The aqueous portion of the waste stream was neutralized with sodium hydroxide and transferred to the tank farm. Overflow from these tanks was disposed to various cribs in the 200 East Area including the BC Cribs and Trenches. More information is available in the *U Plant Source Aggregate Area Management Study Report* (DOE/RL 1992a).

2.2.2 Potential Pathways for Liquid Discharged to the Vadose Zone to Migrate to Unconfined Aquifer

The depth to groundwater beneath liquid disposal sites within the 200 East Area is approximately 91 m (300 ft) below ground surface. Depth to groundwater decreases eastward toward the river. The driving force for contamination migration from the disposal sites in the 200 East Area is the disposal event itself. The *200 East Groundwater Aggregate Area Management Study Report* (200 East Groundwater AAMSR) (DOE/RL 1993c) presents an evaluation of surface sites for potential contaminant migration to groundwater. This evaluation estimates possible groundwater impact by comparing VZ moisture retention capacity to the volume of liquid disposed. Those sites that received liquids of a volume greater than the capacity of the VZ were identified as having the potential to impact groundwater. The PUREX AAMSR evaluated each of the waste sites within this 200-PO-1 Groundwater OU and identified the sites that have the potential to impact groundwater. Table 2-1 lists waste sites above the 200-PO-1 Groundwater OU and the potential for past migration of liquid discharges from the waste sites to migrate to the unconfined aquifer.

Table 2-1. Waste Sites Above the 200-PO-1 Operable Unit.

Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC
Cribs			**Trenches**			**French Drains**	**Nitrate**		**Septic Systems**		
216-A-1	PW-2	N	216-A-18	PW-2	Y	216-A-11	MW-1	Y	2607-E6	ST-1[b]	N
216-A-2	PW-3	N	216-A-19	PW-2	Y	216-A-12	MW-1	Y	2607-E7	ST-1[b]	N
216-A-3	PW-2	Y	216-A-20	PW-2	Y	216-A-13	MW-1	Y	2607-E8	ST-1[b]	N
216-A-4	MW-1	Y	216-A-40	CW-1	N	216-A-14	MW-1	N	2607-E11	ST-1[b]	N
216-A-5	PW-2	Y	216-B-20	TW-1[a]	Y	216-A-15	LW-2	Y	2607-E12	ST-1[b]	N
216-A-6	SC-1	Y	216-B-21	TW-1[a]	Y	216-A-16	PO-3	Y	2607-EE	ST-1[b]	N
216-A-7	PW-3	Y	216-B-22	TW-1[a]	Y	216-A-17	PO-3	Y	2607-EK	ST-1[b]	N
216-A-8	PW-3	Y	216-B-23	TW-1[a]	Y	216-A-23A	PO-3	N	2607-EL	ST-1[b]	N
216-A-9	CW-1	Y	216-B-24	TW-1[a]	Y	216-A-23B	PO-3	N	2607-EM	ST-1[b]	N
216-A-10	PW-2	Y	216-B-25	TW-1[a]	N	216-A-22	MW-1	N	2607-EN	ST-1[b]	N
216-A-21	MW-1	Y	216-B-26	TW-1[a]	Y	216-A-26	MW-1	Y	2607-EO	ST-1[b]	N
216-A-24	PW-3	Y	216-B-27	TW-1[a]	N	216-A-26-A	MW-1	Y	2607-EP	ST-1[b]	N
216-A-27	MW-1	Y	216-B-28	TW-1[a]	Y	216-A-28	PW-2	Y	2607-EQ	ST-1[b]	N
216-A-30	SC-1	Y	216-B-29	TW-1[a]	Y	216-A-33	MW-1	N	2607-ER	ST-1[b]	N
216-A-31	PW-3	N	216-B-30	TW-1[a]	Y	216-A-35	MW-1	N	2607-ER1	ST-1[b]	N
216-A-32	MW-1	N	216-B-31	TW-1[a]	N			N	2607-EZ	ST-1[b]	N
216-A-36A	PW-2	Y	216-B-32	TW-1[a]	Y	**Ponds**			2607-GF	ST-1[b]	N
216-A-36B	PW-2	Y	216-B-33	TW-1[a]	Y	216-B-3	CW-1	Y			
216-A-37-1	PW-4	Y	216-B-34	TW-1[a]	Y	21-6B-3A, B, C	CW-1	N	**Unplanned Releases**		
216-A-37-2	SC-1	Y	216-B-52	TW-1[a]	Y	2101-M Pond	CW-1	N	200-E-43	UR-1	N
216-A-38-1	MW-1	N	216-B-53-A	TW-1[a]	Y				200-E-44	UR-1	N
216-A-39	PO-3	N	216-B-53-B	TW-1[a]	N	**Ditches**			200-E-103	UR-1	N
216-A-41	MW-1	N	216-B-54	TW-1[a]	N	216-A-29	CS-1	Y	200-E-107	UR-1	N
216-A-45	PW-4	Y	216-B-58	TW-1[a]	N	216-A-34	PW-4	N	UPR-200-E-10	UR-1	N
216-B-14	TW-1[a]	Y			N				UPR-200-E-12	UR-1	N
216-B-15	TW-1[a]	Y	**Burial Sites**			**Tank Farms, etc.**			UPR-200-E-17	UR-1	N
216-B-16	TW-1[a]	Y	Nonradioactive			241-A (6)	SST	N	UPR-200-E-18	UR-1	N
216-B-17	TW-1[a]	Y	Dangerous			241-AP (7)	DST	N	UPR-200-E-19	UR-1	N
216-B-18	TW-1[a]	Y	Waste Landfill	SW-2	N	241-AW (6)	DST	N	UPR-200-E-29	UR-1	N
216-B-19	TW-1[a]	Y				241-AX (4)	SST	N	UPR-200-E-33	UR-1	N
			Solid Waste			241-AY (2)	DST	N	UPR-200-E-36	UR-1	N
Retention Basins			216-E-1	SW-2	N	241-AZ (2)	DST	N	UPR-200-E-142	UR-1	N
207-A-North	SC-1	N				Diversion Boxes			UPR-200-E-143	UR-1	N
207-A-South	SC-1	N									

[a]200-TW-1 was changed to 200-BC-1 in 2007.
[b]200-ST-1 was changed to 200-MG-1 in 2007.
*PC = potential contribution.

DST = double-shell tank.
OU = operable unit.
SST = single-shell tank.

2.3 REGULATORY BACKGROUND

The 200-PO-1 Groundwater OU originally was defined as a combined source and groundwater OU. In June 1993, the OU was redesignated as only a groundwater OU in order to implement recommendations from the PUREX and B Plant AAMSRs (DOE/RL 1993a and 1993b) and the 200 East Groundwater AAMSR (DOE/RL 1993c).

The AAMSRs for the 200 East and West Areas were developed to support the decision-making process outlined in the *Hanford Past-Practice Strategy* (DOE/RL 1991). Also in 1993, Ecology was designated the Lead Regulatory Agency and it was agreed that groundwater OUs would be addressed as CERCLA past-practice units. While the groundwater is remediated under CERCLA, there is ongoing RCRA monitoring as well.

In 1994, the cleanup strategy documents for the Columbia River and Hanford Groundwater change packages were issued to implement the selection of three remedial strategy documents for submittal in lieu of OU work plans under Tri-Party Agreement milestone series M-013.

Milestone M-013-94-03 (May 1995) provided for the implementation of the 1994 Refocusing Negotiations and modified M-013 milestones for completion of the 200 Area National Priorities List pre-record of decision (ROD). The milestone also established Milestone M-03-10 for submittal of the 200-PO-1 Groundwater OU RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) Work Plan by October 31, 1995; changed the 200-PO-1 Groundwater OU unit category from CERCLA past practice to "RCRA past-practice"; and kept Ecology as the designated Lead Regulatory Agency.

In July 1995, Milestone M-013-95-01 changed milestone M-013-10 to "Submit the 200-PO-1 OU RFI/CMS Work Plan" and added three new M-015 milestones, which were completed as scheduled.

In February 2002, an M-013 Milestone change provided for the submittal of 200 Area RI/FS work plans to complete the investigation of past-practice units. In November 2006, the Tri-Parties (Ecology, DOE, and EPA) developed Milestone M-013-10A for the preparation of the 200-PO-1 Groundwater OU RI/FS Work Plan to be completed by September 30, 2007. This document is written to fulfill Milestone M-013-10A.

3.0 SUMMARY OF HISTORICAL INVESTIGATIONS

3.1 CERCLA PROCESS HISTORY FOR THE 200-PO-1 GROUNDWATER OPERABLE UNIT

Groundwater monitoring at the 200-PO-1 Groundwater OU is conducted under three major programs: CERCLA; RCRA past practice; and *Washington Administrative Code* and *Atomic Energy Act of 1954* (AEA) monitoring. The general objectives of these programs are to (1) determine groundwater quality baseline conditions, (2) characterize hydrogeologic and chemical trends in the groundwater system, (3) assess existing and emerging groundwater quality problems, and (4) support analyses such as groundwater flow and contaminant fate and transport modeling. Table 3-1 summarizes the contents of documents that describe previous 200-PO-1 Groundwater OU investigations and selected Hanford Site-wide groundwater documents that provide reference information pertinent to the 200-PO-1 Groundwater OU. Sections 3.2 through 3.8 provide brief summaries of previous major investigations associated with groundwater quality and contaminant sources within the 200-PO-1 Groundwater OU.

3.2 200 EAST GROUNDWATER AGGREGATE AREA MANAGEMENT STUDY REPORT

The purpose of the 200 East Groundwater AAMSR (DOE/RL 1993c) was to compile and evaluate the existing body of knowledge from within the 200 East Area to support the *Hanford Past-Practice Strategy* (DOE/RL 1991). This scoping level study provided the basis for initiating RI/FS activities. This report also integrates select RCRA TSD activities with CERCLA and RCRA past-practice investigations.

The 200 East Groundwater AAMSR (DOE/RL 1993c) summarizes information about groundwater contaminants beneath the 200 East Area and provides recommendations for prioritizing, investigating, and conducting remediation of various contaminants and any associated plumes. The document provides a detailed description of radiological and nonradiological contaminant plumes in the 200-PO-1 Groundwater OU. Radiological plumes included I-129, Sr-90, Tc-99, Cs-137, and tritium, and the nonradiological plumes included nitrate and cyanide. In the past, the plumes have migrated radially from several groundwater mounds in the 200-PO-1 Groundwater OU. As the liquid discharges ceased, the groundwater (and entrained plumes) reverted to a general eastward flow. Quantities of reported chemical wastes are shown by waste sites in this document.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
Bryce, R. W., C. T. Kincaid, P. W. Eslinger, and L. F. Morasch, 2002, *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability*, PNNL-14027	In 1999, the DOE initiated the development of an assessment tool that will enable the users to model the movement of contaminants from all waste sites at the Hanford Site through the VZ, groundwater, and the Columbia River and estimate the impact of contaminants on human health, ecology, and the local cultures and economy. This tool was named the SAC. An assessment recently was completed with the SAC that demonstrates it is a functional assessment capability. Future modifications to the tool will be driven by the requirements of specific assessments. Results will continue to improve as input data are refined through characterization and scientific research. The results of the first runs performed with SAC were presented to the integration project expert panel in September 2000. Analysis performed on these early results identified a number of issues that needed to be addressed before the tool could be considered useful. The major issues were addressed by replacing a simple two-dimensional groundwater model in the SAC with the three-dimensional Hanford Site-wide groundwater model, correcting the quantity of contaminants assigned to several waste sites, and obtaining more efficient hardware for performing analyses. Following the implementation of those changes, the assessment was rerun. The assessment: • Modeled the movement of contaminants from more than 500 locations throughout the Hanford Site representing 890 waste sites through the VZ, groundwater, and the Columbia River • Incorporated data on 10 radioactive and chemical contaminants (carbon tetrachloride, Cs-137, chromium, I-129, Pu-239/240, Sr-90, Tc-99, tritium, total uranium, and U-238) • Focused on subsurface transport, the Columbia River, and risks to human and ecological health, and the economy and culture.
CHG 2005, *Hanford Soil Inventory Model, Rev. 1*, DOE-ORO-26744 (RPP-26744, Rev. 0)	The Hanford SIM is an extension and enhancement of previous efforts to quantify contaminant inventories in the Hanford Site waste-storage tanks. In the 1990s, the Hanford Defined Waste Model was used to predict the contents of the single- and double-shell tanks at the Hanford Site. The data gathered as part of that modeling effort included fuel processed, chemical process knowledge, and waste transfer information. The Hanford Defined Waste Model also made an initial attempt to define what was disposed to the ground. The SIM Rev. 1 effort provides more details of what went into specific waste sites other than the tanks and provides a more complete picture of these discharges.
CHG 2003, *Subsurface Conditions Description of the C and A-AX Waste Management Area*, RPP-14430, Rev. 0	This document discusses the subsurface conditions relevant to the occurrence and potential migration of contaminants in the groundwater underlying the C, A, and AX Tank Farms. It also describes the available environmental contamination data and contains a limited, qualitative interpretation of the data as they apply to contaminant behavior. This document aided in selecting a characterization approach, and focused on site-specific data that defined the occurrence and migration of contaminants. The outcome of this report states that the regional distribution of contaminants near the C and A-AX Tank Farms was moderate, and it was determined that there was no clear indication of vadose contamination within these waste management areas being a source.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
DOE/RL 1993c, *200 East Groundwater Aggregate Area Management Study Report*, DOE/RL-92-19, Rev. 0	See Section 3.2 for a summary of this document.
DOE/RL 1993a, *PUREX Plant Source Aggregate Area Management Study Report*, DOE/RL-92-04, Rev. 0	See Section 3.3 for a summary of this document.
DOE/RL 1993b, *B Plant Source Aggregate Area Management Study Report*, DOE/RL-92-05, Rev. 0	See Section 3.4 for a summary of this document.
DOE/RL 1996a, *200-PO-1 Operable Unit Permit Modification*, DOE/RL-96-59, Draft A	This RCRA permit modification describes a proposed interim action for the 200-PO-1 Groundwater OU. The objectives of this corrective action are to limit human exposure to contaminated groundwater and to protect the Columbia River. This permit modification has been developed in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989) and summarizes more detailed information available in other documents, such as the *200 East Groundwater Aggregate Area Management Study Report* (DOE/RL 1993c) and the *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit* (DOE/RL 1997a). This permit modification fulfills the M-15-25B Milestone for the 200-PO-1 Groundwater OU.
DOE/RL 1997a, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*, DOE/RL-95-100, Rev. 1	See Section 3.5 for a summary of this document.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
DOE/RL 1997b, *Waste Site Grouping for 200 Areas Soil Investigations*, DOE/RL-96-81, Rev. 0	The analogous site approach concept was a key element in the development of the *200 Areas Soil Remediation Strategy – Environmental Restoration Program* (DOE/RL 1996b) because many of the 200 Area waste sites share similarities in geological conditions, functions, and types of waste received. As a result, the need to establish waste site groups for 200 Area waste sites was identified as an initial step in the implementation of the *200 Areas Soil Remediation Strategy – Environmental Restoration Program*. The purpose of this document was to identify logical waste site groups for characterization based on criteria established in the *200 Areas Soil Remediation Strategy – Environmental Restoration Program*. Specific objectives of the document included the following. • Finalize waste site groups based on the approach and preliminary groupings identified in the *200 Areas Soil Remediation Strategy – Environmental Restoration Program.* • Prioritize the waste site groups based on criteria developed in the *200 Areas Soil Remediation Strategy – Environmental Restoration Program.* • Select representative sites that best represent typical and worst-case conditions for each waste group. • Develop conceptual models for each waste group. Waste site group prioritization and representative site selection will support a more efficient and cost-effective approach to characterizing the 200 Area waste sites. Characterization efforts will be limited to representative sites, the data from which will be used for remedial action decisions for all waste sites within a group (consistent with the analogous site approach). Waste site group properties will be used to establish a sequence in which the representative sites are expected to be addressed. The conceptual models developed in this document provide an initial prediction of the nature and extent of primary COPC and support the selection of representative sites and prioritization of groups.
DOE/RL 1997c, *RCRA Corrective Measures Study for the 200-PO-1 Operable Unit*, DOE/RL-96-66, Rev. 1	See Section 3.6 for a summary of this document.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
DOE/RL 1999a, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, DOE/RL-98-28, Rev. 0	The Implementation Plan outlines the framework for implementing assessment activities in the 200 Area to ensure consistency in documentation, level of characterization, and decision making. The Implementation Plan also consolidates background information and other typical work plan materials, to serve as a single reference source for this type of information. This Implementation Plan does not provide detailed information about the assessment of individual waste sites or groups. Site-specific data needs, DQOs, data collection programs, and associated assessment tasks and schedules will be defined in subsequent group-specific (i.e., OU-specific) work plans. A common regulatory framework is established that integrates the RCRA, CERCLA, Federal facility regulations, and *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989) requirements into one standard approach for 200 Area cleanup activities. The Implementation Plan also streamlines work plans that are required for each waste site group by consolidating background information providing a single referenceable source of this information. This allows the information in the group-specific work plans to focus on waste group or waste site-specific information. The background information includes an overview of the 200 Area facilities and processes, their operational history, contaminant migration concepts, and a list of COPCs. It also documents and evaluates existing information to develop a site description and conceptual model of expected site condition and potential exposure pathways. With this conceptual understanding, preliminary potential applicable or relevant and appropriate requirements, preliminary remedial action objectives, and remedial action alternatives are identified. The alternatives are broadly defined but represent potential alternatives that may be implemented at the site. The identification of potential alternatives helps ensure that the data needed to fully evaluate the alternatives are collected during the remedial investigation. The specific type and quality of data are to be defined through the site-specific DQOs and form the basis for the data collection programs. The 200 Areas strategy recognized the interrelationships between the various activities in the area and the need to integrate with other environmental restoration and Hanford Site projects/programs. The Implementation Plan describes the approach to interfacing with other programs and agencies, the integrated schedule of activities that addressed RCRA and CERCLA program requirements, and the public participation process.
DOE/RL 1999b, *Retrieval Performance Evaluation Methodology for the AX Tank Farm*, DOE/RL-98-72	The retrieval performance evaluation methodology for the AX Tank Farm was prepared to develop methodologies and identify data needs required to support the DOE and Washington State Department of Ecology decisions. The retrieval performance evaluation uses the AX Tank Farm as a basis for demonstrating a decision tool that supports waste retrieval and tank farm closure decisions. Three strategies were developed to support a comparison of the performance of waste retrieval and tank closure options. In addition to developing strategies, an uncertainty and sensitivity analysis was conducted for the tank farm system and is presented in this document.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
DOE/RL 2000, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*, DOE/RL-99-07, Rev. 0	This Work Plan provides the details for characterizing chemical, radiological, and physical conditions in soil at four selected waste sties in the 200-CW-1 OU. It also identifies preliminary remedial action alternatives that are likely to be considered for remediation of the OU. The preliminary remedial alternatives will be further developed and agreed to in the FS/Closure Plan, the proposed permit modification, and the eventual ROD and the Hanford Facility RCRA Permit Modification for this OU.
DOE/RL 2003, *Hanford's Groundwater Management Plan: Accelerated Cleanup and Protection*, DOE/RL-2002-68, Rev. 0	This document lays out a plan developed by the DOE, in conjunction with the EPA and the Washington State Department of Ecology, to accelerate cleanup. The goal is to return groundwater to its highest beneficial use where practicable or which will at least prevent further degradation. The previous baseline shows remediation beginning in 2008 and extending to 2024. The new accelerated schedules illustrated in this document show that the baseline will begin in 2004 and be completed by 2012. The document contains discussion of specific results that can be expected using the accelerated plan for cleanup. These results and expected dates of completion include the following. • Remediate high-risk wastes by 2011. • Shrink the contaminated areas by 2112. • Reduce recharge by 2012. • Remediate groundwater by 2012. • Evaluate groundwater monitoring needs (ongoing). Plans to deal with waste sites close to the tank farms require further work and will depend greatly on the strategy employed to close the tanks. The regions selected for completion by 2012 avoid those areas immediately adjacent to tank farms until an integrated approach to waste site remediation and tank closure can be developed. In addition to accelerated schedules for cleanup and groundwater protection, the document contains definitions and discussions of various proposed groundwater protection boundaries (e.g., core zone and outside the core zone). As part of the integrated accelerated plan, an area closure strategy for the Central Plateau is discussed. When cleanup is implemented on an area-by-area basis, these coordinated efforts to control sources, implement remedial action, and assess and monitor impact are expected to place major portions of the Central Plateau into a condition of long-term stewardship monitoring starting in 2006.
DOE/RL 2004, *Waste Control Plan for the 200-PO-1 Operable Unit*, DOE/RL-2004-18	This Waste Control Plan governs the management of IDW generated from groundwater well sampling; aquifer sampling-tube installation and seed sampling; aquifer testing; groundwater well installation and development; aquifer sampling-tube installation and development; well maintenance, decommissioning and alteration; water-level measurements (both manual and transducer); geophysical logging; screening analysis liquids; and equipment decontamination for the 200-PO-1 Groundwater OU investigations, as appropriate. The scope of this work for the 200-PO-1 Groundwater OU is further described in the *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit* (DOE/RL 2005a).

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
DOE/RL 2005a, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*, DOE/RL-2003-04, Rev. 1	The objective of this SAP is to provide groundwater data necessary to track the extent and concentration of groundwater contaminant plumes. The data will be used to meet the requirements for RI/FS scoping under CERCLA, 40 CFR 300.430(b), "Remedial Investigation/Feasibility Study and Selection of Remedy"] and Site-wide surveillance monitoring under the *Atomic Energy Act of 1954*. This document describes groundwater sampling and analysis requirements for the 200-PO-1 Groundwater OU and specifies wells and aquifer sampling tubes to be monitored, constituents to be analyzed, and the frequency of sampling. This SAP organizes the wells by their proximity to the sources of the major contaminant plumes in the 200 East Area. Wells located near the plume sources are termed near-field wells, and wells farther from sources are far-field wells. The constituents that are analyzed and their respective schedules are reported in this document. The rationale for selecting certain COPCs for sampling and analysis is explained in detail in the *Data Quality Objectives Summary Report-Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units* (PNNL 2002).
DOE/RL 2005b, *Feasibility Study for the BC Cribs and Trenches Area Waste Sites Hanford Site, Richland, Washington,* DOE/RL-2004-66, Draft A	The purpose of this Feasibility Study is to develop and evaluate alternatives for remediation of the 28 waste sites in the BC Cribs and Trenches Area and t function as a supporting document to the proposed plan. This Feasibility Study refines preliminary potential applicable or relevant and appropriate requirements, remedial action objectives, and general response actions initially identified in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE/RL 1999a). An initial remedial alternative development activity provided the basis for developing a focused range of viable alternatives for the BC Cribs and Trenches Area waste sites. The alternatives considered in this Feasibility Study include a range of response actions (no further action; removal, treatment, and disposal; containment [capping]; and containment combined with limited "hot spot" removal [partial removal, treatment, and disposal]) that are appropriate to address site-specific conditions.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
FH 2003b, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*, CP-15329	The purpose of the DQO process was to assess the current groundwater monitoring well networks for the 200 West and 200 East areas. This assessment was needed to address changing contaminant plume conditions (e.g., plume migration) and to ensure that monitoring activities meet the requirements for remediation performance monitoring (i.e., CERCLA monitoring), Site-wide surveillance monitoring to meet the requirements of DOE orders, and detection/assessment monitoring to meet the requirements of RCRA. This DQO Summary Report was prepared in support of DOE's Cleanup, Constraints, and Challenges Team process. Because of the changing shape of the groundwater contaminant plume contours over time and changing programmatic needs, the 200 West and 200 East groundwater monitoring network is required to be periodically reevaluated. The objective of the groundwater CERCLA remediation performance monitoring program is to provide a routine assessment of the effectiveness of groundwater remediation activities within the 200-PO-1 Groundwater OU. The objectives of the Site-wide surveillance-monitoring program are as follows. • Determine baseline conditions of groundwater quality and quantity. • Characterize and define hydrogeologic, physical, and chemical trends in the groundwater system. • Identify existing and potential groundwater contamination sources. • Assess existing and emerging groundwater quality problems. • Evaluate existing and potential offsite impacts of groundwater contamination. • Provide data on which decisions can be made concerning land disposal practices and the management and protection of groundwater resources. Finally, the objective of the RCRA detection program is to identify if TSD units are impacting groundwater quality. If impacts to groundwater are detected, the objective of the RCRA assessment program is to define the rate and extent of contaminant migration. This DQO process identified the optimum number of groundwater wells to be monitored to meet these objectives and determined that a number of new groundwater wells needed to be installed. The identity of wells in the monitoring network, sampling frequency, the analyses to be performed, the detection limit requirements, and other analytical performance requirements (e.g., precision and accuracy) were defined in this document. The resultant groundwater monitoring network fulfilled the needs of the three major Hanford Site regulatory monitoring activities (CERCLA, RCRA, AEA).
FH 2004 *Historical Site Assessment of the Surface Radioactive Contamination of the BC Controlled Area*, WMP-18647, Rev. 0	This report is a historical site assessment of the BC Cribs and Trenches Area. This assessment has three main parts: a chronological narrative, a review of the information found that is pertinent to a conceptual model, and the descriptions of the conceptual models themselves. This document also presents a comprehensive reference list of documents pertinent to disposal practices in the BC Cribs and Trenches Area.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
PNNL 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, PNNL-11800	A composite analysis was prepared for the Hanford Site considering only sources in the 200 Area Plateau. Estimating doses to hypothetical members of the public for the Composite Analysis was a multi-step process involving the estimation or simulation of inventories; waste release to the environment; migration through the VZ, groundwater, and atmospheric pathways; and exposure and dose. Doses were estimated for scenarios based on agriculture, residential, industrial, and recreational land use. The radionuclides included in the VZ and groundwater pathway analyses of future releases were C-14, Cl-36, Se-79, Tc-99, I-129, and uranium isotopes. In addition, tritium and Sr-90 were included because they exist in groundwater plumes. Radionuclides considered in the atmospheric pathway included tritium and C-14. The analysis indicated that most of the radionuclide inventory in past-practice liquid discharge and solid waste burial sites on the 200 Area Plateau was projected to be released in the first several hundred years following Hanford Site closure. The radionuclide doses for all of the exposure scenarios outside of a defined buffer zone were all less than 3 mrem/yr, well below the performance objectives of 100 mrem/year or the ALARA objective of 30 mrem/year. Several sources of uncertainty were noted in the first iteration of the Composite Analysis, with the largest uncertainty associated with the inventories of key mobile radionuclides. Other sources of uncertainty in the analysis arose from the conceptual and numerical models of contaminant migration and fate in the VZ and assumption regarding source-term release models and end states. The composite analysis demonstrated a significant separation in time between past-practice discharges and disposals, and active and planned disposal of solid waste, environment restoration waste, and immobilized low-activity waste. The higher integrity disposal facilities and surface covers of these active and planned disposal delay releases, and the releases do not superimpose on the plumes from the near-term past-practice disposals.
PNNL 2000a, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200 East Area and Vicinity, Hanford Site, Washington*, PNNL-12261	This document provides a refined conceptual model of the hydrogeologic framework of the 200 East Area and vicinity, and addresses probable preferential flow paths from the 200 East Area to the Columbia River.
PNNL 2000b, *Hanford Site Groundwater Monitoring: Setting, Sources, and Methods*, PNNL-13080	This report is a companion volume to the groundwater monitoring report for the Hanford Site, which is produced annually. It contains background information that does not change significantly from year to year. This report includes a description of groundwater monitoring requirements, site hydrogeology, and waste sites that have affected groundwater quality or that require groundwater monitoring. Monitoring networks and methods for sampling, analysis, and interpretation are summarized. VZ monitoring methods and statistical methods also are described.

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
PNNL 2002, *Data Quality Objectives Summary Report-Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units*, PNNL-14049	The purpose of this document is to present the DQOs that will be used to assess the current groundwater monitoring approach and redesign the well-field network for the 200-BP-5 and 200-PO-1 Groundwater OUs. This assessment is needed to address changing contaminant plume conditions (e.g., plume migration) and to ensure that monitoring activities meet the requirements for remediation performance monitoring (i.e., CERCLA monitoring), RCRA past-practice monitoring, and Site-wide surveillance monitoring (AEA) activities as directed in DOE orders. This DQO Summary Report was prepared in response to the EPA 5-year review of groundwater remedial actions of the Hanford Site and supports Action Items 200-7 and 200-8 (*EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* [EPA 2001]). Because of the changing configuration of the groundwater contaminant plume contours over time and the identification of new specific monitoring needs, the 200-BP-5 and 200-PO-1 Groundwater OU groundwater-monitoring networks require periodic reevaluation. Groundwater remediation is not currently being performed in the 200 East Area. This is because some of the contaminants associated with the plumes are not considered to pose a risk to the public at current concentrations and area distributions while other contaminants are at too low a level to be effectively remediated using currently known technologies. However, monitoring groundwater contamination in the area is necessary to determine if contaminant levels are attenuating with time and to ensure that no new or previously unidentified groundwater contamination goes undetected. This DQO process identified the optimum number of groundwater wells to be monitored to meet these objectives and determined that a number of new groundwater wells needed to be installed. The identity of wells in the monitoring network, sampling frequency, the analyses to be performed, the detection limit requirements, and other analytical performance requirements (e.g., precision and accuracy) were defined in this document. The resultant groundwater monitoring network fulfilled the needs of the three major Hanford Site regulatory monitoring activities (CERCLA, RCRA, AEA).
PNNL 2005b, *Interim Status RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and the 216-A-37-1 PUREX Cribs*, PNNL-11523, Rev. 1	This document presents a groundwater monitoring program for three RCRA waste management units combined under one groundwater quality assessment program. These three units are 216-A-10, 216-A-36B, and the 216-A-37-1 Cribs (PUREX Cribs). The three cribs were grouped together based on their proximity to one another, similar construction and waste history, and similar hydrogeologic regime. The monitoring network comprises near-field wells (in the immediate vicinity of the cribs) and far-filed wells (wells downgradient). The monitoring strategy for the near-field wells is included in this plan, while the monitoring strategy for far-field wells is found in the *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit* (DOE/RL 2005a). Results of groundwater monitoring are reported annually in groundwater monitoring reports (e.g., *Hanford Site Groundwater Monitoring for Fiscal Year 2006* [PNNL 2007]).

Table 3-1. Previous Investigations and Existing References. (10 Pages)

Reference	Summary
PNNL 2007, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*, PNNL-16346	This report presents the results of groundwater monitoring and remediation for fiscal year 2006 on the Hanford Site. Water level monitoring was performed to evaluate groundwater flow directions, to track changes in water levels, and to relate such changes to evolving disposal practices. The most extensive plumes are tritium, I-129, and nitrate, which all had multiple sources, and are mobile in groundwater. The largest portions of these plumes are migrating from the central Hanford Site (central plateau) to the southeast, toward the Columbia River. Concentrations of tritium, nitrate, and other contaminants continued to exceed drinking water standards in groundwater discharging to the river in fiscal year 2005. However, contaminant concentrations in river water remained low and were far below standards. This report describes the major COPCs within the 200-PO-1 Groundwater OU including tritium, nitrate, I-129, and Tc-99 as well as other COPCs. Previous Hanford Site groundwater monitoring reports present data on the Hanford Site from 1988 to 2006 are not listed here, but can be located online at http://libraryweb.pnl.gov/ . The latest document (shown here) was used as a reference guide.
WHC 1992, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, WHC-SD-EN-TI-019	See Section 3.7 for a summary of this document.

AAMSR = aggregate area management study report.
AEA = *Atomic Energy Act of 1954*.
ALARA = as low as reasonably achievable.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.
COPC = contaminant of potential concern.
DOE = U.S. Department of Energy.
DQO = data quality objective.
EPA = U.S. Environmental Protection Agency.
FS = feasibility study.
OU = operable unit.
PUREX = Plutonium-Uranium Extraction (Plant or process).
RCRA = *Resource Conservation and Recovery Act of 1976*.
RI/FS = remedial investigation/feasibility study.
RL = U.S. Department of Energy, Richland Operations Office.
ROD = record of decision.
SAC = system assessment capability.
SAP = sampling and analysis plan.
SIM = *Hanford Soil Inventory Model, Rev. 1* (RPP-26744) (CHG 2005).
Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order*.
TSD = treatment, storage, and/or disposal.
OU = operable unit.
VZ = vadose zone.

For the 200 Areas, the first step in the strategy was to evaluate the existing information presented in the 200 East Groundwater AAMSR (DOE/RL 1993c). Based on the information, decisions were made regarding which strategy path(s) to pursue for further actions. These strategies included three paths for interim decision-making and a final remedy selection process that incorporates the three paths and integrates sites not addressed in those paths. The three paths for decision making are as follows:

- Expedited response action (ERA) path, where an existing or near-term unacceptable health or environmental risk from a site is determined or suspected, and a rapid response is necessary to mitigate the problem.
- Interim remedial measure (IRM) path, where existing data are sufficient to indicate that the site poses a risk through one or more pathways and additional investigations are not needed to screen the likely range of remedial alternatives for interim actions; if a determination is made that an IRM is justified, the process proceeds to select an IRM remedy and a focused feasibility study, if needed to select a remedy.
- Limited field investigation (LFI) path, where minimum site data are needed to support IRM or other decisions, and are obtained in a less formal manner than that needed to support a final ROD. Data generated from an LFI may be sufficient to directly support an interim ROD.

The 200 East Groundwater AAMSR recommended that an ERA be initiated for the highest concentration portion of the Sr-90 plume. The Sr-90 plume overlaps at two nearby wells within the highest concentrations of the Cs-137 and Pu-239/240 plumes, both of which were proposed for other remedial paths. While the ERA was designated to focus on removing Sr-90, the other two radiological contaminants will be removed during the ERA as well. The 200 East Groundwater AAMSR also recommended an IRM for Tc-99. Because the Tc-99 plume effectively coincides with the nitrate plume, cyanide, and cobalt-60 plumes, all these plumes would be addressed collectively under one single multi-contaminant IRM. IRMs also were proposed for Cs-137, Pu-239/240, and uranium, including all isotopes. The 200 East Groundwater AAMSR recommended that inorganic constituents that present risk would require at least an LFI assessment of background levels to confirm potential risks before an IRM could be initiated. Constituents recommended for an LFI included aluminum, antimony, arsenic, beryllium, cadmium, chromium, selenium, and thallium. It was also recommended that similar studies (under the RI rather than an LFI) would be necessary before a risk assessment could be completed for barium, boron, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, nickel, potassium, silver, sodium, strontium, vanadium, and zinc. The LFI activities were recommended in support of other possible IRMs for organics which included verification and/or plume delineation for bis-(2-ethylhexyl)-phthalate, 2,4-dinitrotoluene, 2,4-dinitrophenol, and pentachlorophenol. Among the radionuclides tritium was proposed for inclusion in the final remedy risk assessment, while gross alpha and beta were proposed for LFIs.

3.3 PUREX SOURCE AGGREGATE AREA MANAGEMENT STUDY REPORT

This report presents the results of an aggregate area management study for the PUREX Plant in the 200 Areas. The purpose of the PUREX AAMSR (DOE/RL 1993a) was to compile and evaluate the existing body of knowledge from within the 200 East Area to support the *Hanford Past-Practice Strategy* (DOE/RL 1991). This report provides the basis for initiating an RI/FS under CERCLA or an RFI/CMS under RCRA. This report also integrates RCRA TSD closure activities with CERCLA and RCRA past-practice investigations.

This document describes the general site conditions (geology, hydrology, ecology, meteorology) and the demography. The major facilities within the aggregate area are presented with information on the processes and operational history. The report lists waste disposal activities and the types of waste that were generated, as well as quantities of waste disposed to waste management units (if known). This report also identifies chemicals used or disposed of within the aggregate area that could be of concern regarding public health/environment. A preliminary conceptual site model that summarizes the conceptual understanding of the aggregate area with respect to types and the extent of contamination is presented, along with exposure pathways and receptors. The report also describes the screening process for determining the relative priority of follow-up action at each waste management unit.

For the 200 Areas the first step in the strategy was to evaluate the existing information presented in the PUREX AAMSR. Based on the information, decisions were made regarding which strategy path(s) to pursue for further actions in this area. These strategies included three paths for interim decision making and a final remedy selection process that incorporates the three paths and integrates sites not addressed in those paths (ERA, IRM, and LFI). Based on the results presented, recommendations were provided for ERAs at problem sites, as well as any IRMs and LFIs.

Three waste management units met the criteria for ERAs. Most of the waste management units were not recommended for ERAs because of the lack of a driving force to an exposure pathway. Inactive cribs, ponds, and trenches no longer receive waste and, therefore, artificial recharge is no longer a driving force for moving subsurface contaminants. Twenty-five out of 90 units and unplanned releases were identified as high-priority units and assessed as candidates for IRMs. Twenty-five of the 90 units were recommended to undergo LFIs. Overall, an RI was recommended for the PUREX Plant Aggregate Area.

3.4 B PLANT SOURCE AGGREGATE AREA MANAGEMENT STUDY REPORT

This report presents the results of an aggregate area management study for the B Plant in the 200 Areas. The purpose of the B Plant AAMSR (DOE/RL 1993b) was to compile and evaluate the existing body of knowledge from within the 200 East Area to support the *Hanford Past-Practice Strategy* (DOE/RL 1991). This report provides the basis for initiating an RI/FS under CERCLA or an RFI/CMS under RCRA. This report also integrates RCRA TSD closure activities with CERCLA and RCRA past-practice investigations.

This document describes the general site conditions (geology, hydrology, ecology, meteorology) and the demography. The major facilities within the aggregate area are presented with information on the processes and operational history. The report lists waste-disposal activities and the types of waste that were generated, as well as quantities of waste disposed to waste management units. This report also identifies chemicals used or disposed of within the aggregate area that could be of concern regarding public health/environment. A preliminary conceptual site model that summarizes the conceptual understanding of the aggregate area with respect to types and the extent of contamination is presented, along with exposure pathways and receptors. The report also describes the screening process for determining the relative priority of follow-up action at each waste management unit.

For the 200 Areas the first step in the strategy was to evaluate the existing information presented in the B Plant AAMSR. Based on the information, decisions were made regarding which strategy path(s) to pursue for further actions in this area. These strategies included three paths for interim decision-making and a final remedy selection process that incorporates the three paths and integrates sites not addressed in those paths (ERA, IRM, and LFI) .

The 216-B-5 Reverse Well was the only unit recommended for an ERA. There were 51 waste management units and unplanned releases that met the criteria as candidates for an ERA. To be considered a candidate, the waste management unit must have been within the scope of an operational program for inclusion as an ERA. Most of the waste management units were not recommended for ERAs because of the lack of a driving force to an exposure pathway. Inactive cribs, ponds, and trenches no longer receive waste and, therefore, artificial recharge is no longer a driving force to move subsurface contaminants. Sixty-one of the 139 units were identified as high-priority waste management units and addressed as candidates for IRMs. Seventy-three of the 139 units and unplanned releases were recommended to undergo LFIs. Overall, an RI was recommended for the B Plant Aggregate Area.

3.5 RCRA FACILITY INVESTIGATION REPORT FOR THE 200-PO-1 GROUNDWATER OPERABLE UNIT

The *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit* (DOE/RL 1997a) was prepared in support of the RFI/CMS process for the 200-PO-1 Groundwater OU. The RFI document was prepared in lieu of an RFI/CMS Work Plan since the EPA, Ecology, and the DOE agreed that sufficient data were available to prepare an RFI. The RFI report summarizes existing information on the 200-PO-1 Groundwater OU presented in the 200 East Groundwater and PUREX AAMSRs (DOE/RL 1993c and 1993a), contaminant specific studies, available modeling data, and groundwater monitoring data summary reports. The report presents contaminant information including particular COPCs for each waste site within the 200-PO-1 Groundwater OU, as well as the potential for contaminants from these waste sites to impact groundwater. Appendix A of the RFI presents the summary of the DQO process that was implemented during planning stages for the RFI/CMS. The results from the RFI convey that the groundwater associated with the 200-PO-1 Groundwater OU was impacted by operations at the PUREX and B Plants in the 200 East Area and waste disposal from the U Plant to the BC Cribs and Trenches in the 200 West Area.

3.6 RCRA CORRECTIVE MEASURES STUDY FOR THE 200-PO-1 GROUNDWATER OPERABLE UNIT

The *RCRA Corrective Measures Study for the 200-PO-1 Operable Unit* (DOE/RL 1997c) was prepared to support the RFI/CMS process for the 200-PO-1 Groundwater OU. The CMS report identified, screened, and developed potential remedial alternatives for three major contaminant plumes associated with the 200-PO-1 Groundwater OU (i.e., I-129, nitrate, and tritium). The report established objectives for evaluating potential corrective action measures for addressing contaminant plumes based on information from the RFI report and other supporting documents such as the 200 East Groundwater and PUREX AAMSRs (DOE/RL 1993c and 1993a).

Two remedial actions were evaluated for the I-129 and tritium plumes: (1) no action, and (2) institutional controls. There was no further evaluation of the nitrate plume because the majority of the plume was at concentrations below the maximum contaminant level (MCL). The remedial action chosen for both I-129 and tritium was institutional control. The CMS recommended a no-human contact with contaminated groundwater until contaminant concentrations are reduced through natural attenuation. Restrictions on drinking water wells and providing alternate water supplies would eliminate the ingestion pathway. Access controls to the river, mainly signage and fencing, would be used to limit exposure as well. It was predicted in this report that within 50 years the concentrations of I-129 and tritium would be at or below levels of concern through natural attenuation.

3.7 HYDROGEOLOGIC MODEL FOR THE 200 EAST GROUNDWATER AGGREGATE AREA

The *Hydrogeological Model for the 200 East Groundwater Aggregate Area* (WHC 1992) provides a compilation and evaluation of available hydrogeologic and geochemical data collected in and surrounding the 200 East Area. The data and evaluation efforts were conducted to support the 200 East Groundwater AAMSR. The purpose of this document is to provide a comprehensive overview of groundwater flow characteristics in the 200 East Area. Information found in this document was incorporated into the 200 East Groundwater AAMSR where applicable. The objectives of the document were as follows.

- Compile and analyze hydrogeologic and geochemical data collected from within and surrounding the 200 East Area.
- Describe groundwater flow characteristics for both the unsaturated and saturated zone.
- Develop a comprehensive hydrogeologic conceptual model for the 200 East groundwater aggregate area.
- Identify and describe the nature and extent of groundwater contamination associated with the 200 East Area waste management operations.

3.8 DATA QUALITY OBJECTIVE SUMMARY REPORT FOR ESTABLISHING A RCRA/CERCLA/AEA INTEGRATED 200 WEST AND 200 EAST GROUNDWATER MONITORING NETWORK

The purpose of the DQO process conducted in 2002 and 2003 (FH 2003b) was to assess the groundwater monitoring well networks for the 200 West and 200 East Areas and to develop an integrated groundwater monitoring network. This assessment to addressed changing contaminant plume conditions (e.g., plume migration), and ensured that monitoring activities met the requirements for remediation performance monitoring (i.e., CERCLA monitoring), Site-wide surveillance monitoring to meet the requirements of DOE orders, and detection/assessment monitoring to meet RCRA requirements under 40 CFR 264.99, "RCRA Groundwater Monitoring Checklist." The DQO Summary Report (FH 2003b) was prepared in support of DOE's Cleanup, Constraints, and Challenges Team process.

Because of the changing shape of the groundwater contaminant plume contours and changing programmatic needs, the 200 West and 200 East groundwater monitoring networks are to be periodically re-evaluated. The objective of the groundwater CERCLA remediation performance monitoring program (under 40 CFR 300.420, "Remedial Site Evaluation") is to provide a routine assessment of the effectiveness of groundwater remediation activities within the 200-PO-1 Groundwater OU and 200-BP-1 OUs. The objectives of the Site-wide surveillance monitoring program are as follows.

- Determine baseline conditions of groundwater quality and quantity.
- Characterize and define hydrogeologic, physical, and chemical trends in the groundwater system.
- Identify existing and potential groundwater contamination sources.
- Assess existing and emerging groundwater quality problems.
- Evaluate existing and potential offsite impacts of groundwater contamination.
- Provide data on which decisions can be made concerning land disposal practices and the management and protection of groundwater resources.

The objective of the RCRA detection program (40 CFR 264.99) is to identify if TSD units are impacting groundwater quality. If impacts to groundwater are detected, the objective of the RCRA assessment program is to define the rate and extent of contaminant migration. The DQO process identified the optimum number of groundwater wells to be monitored. To meet the RCRA program objectives and determine whether new groundwater wells were required, the sampling frequency, analyses to be performed, detection limits, and other analytical performance tasks (e.g., precision and accuracy) were established.

The existing groundwater monitoring networks (AEA requirements and DOE O 450.1, *Environmental Protection Program*) within the 200-PO-1 Groundwater OU were reviewed to determine their adequacy for meeting RCRA past-practice requirements. The general far-field and near-field wells were selected from the list of all wells in the 200-PO-1 Groundwater OU based on the results of a geostatistical study of wells within the Hanford Site tritium plume, *Rethinking Groundwater Monitoring at the Hanford Site* (Michael et al., 2000). The results of this study revealed that all available wells in areas of sparse coverage should be retained, whereas only selected wells should be retained in areas of high density.

After an assessment of historical data and regulatory requirements, it was determined that the current required groundwater constituents, sampling frequencies, and water table measurements were adequate. The unconfined aquifer conditions (plume configurations, flow directions, etc.) had not changed significantly since the geostatistics were conducted, and the monitoring well network met all necessary regulatory requirements. The monitoring well network that was in place at the time was deemed compliant.

3.9 CONSIDERATIONS FOR FURTHER INVESTIGATIONS

Following major investigations (see Table 3-1) within the 200-PO-1 Groundwater OU of the 200 Areas, the *Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE/RL 1999a) was developed. This Implementation Plan outlined the framework for implementing assessment activities in the 200 Area to ensure consistency in documentation, level of characterization, and decision making. The Implementation Plan also consolidated background information and other typical work plan materials, serving as a single point of reference for this type of information. This implementation plan does not provide detailed information about the assessment of individual waste sites or groups. Site-specific data needs, data quality objectives (DQO), data collection programs, and associated assessment tasks and schedules are being defined in specific operable unit Work Plans.

A common regulatory framework is established that integrates the RCRA, CERCLA, Federal facility regulations, and Tri-Party Agreement requirements into one standard approach for 200 Area cleanup activities. The implementation plan also streamlines work plans that are required for each waste site group by consolidating background information into a single reference source. This allows information in operable unit work plans to focus on waste groups or to use waste site-specific information in the *Waste Information Database System* (WIDS), the *Hanford Environmental Information System* (HEIS) database, and the *Hanford Soil Inventory Model, Rev. 1* (CHG 2005).

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4.0 WORK PLAN RATIONALE AND SATURATED ZONE CHARACTERIZATION

Many of the previous documents focused on the most critical risk drivers and not the COPCs that pose lower risk. This Work Plan supports the final remedy selection; thus, it must focus on all applicable COPCs and use this information to select the final remedial alternative(s) for the 200-PO-1 Groundwater OU.

Two SAPs support the 200-PO-1 Groundwater OU final decisions. The Characterization SAP (DOE/RL 2007), prepared to further characterize the 200-PO-1 Groundwater OU through additional data collection efforts (provided as Appendix A), and the Monitoring SAP (DOE/RL 2005a), which provides the basis for current routine monitoring and analyses of COPCs (pre-published SAP, provided by electronic reference in Appendix B). The efforts presented in the Characterization SAP are supplemental to those presented in the Monitoring SAP.

As a result of changes in groundwater flow direction, source-term variability, and a decrease in the discharge of other waste streams (e.g., cooling water), the shape and concentration of the COPC plumes within the 200-PO-1 Groundwater OU changed over time. This section identifies the basis for additional data needs beyond those identified by the Monitoring SAP to support characterization of groundwater for the 200-PO-1 Groundwater OU. The characterization data requirements are defined through the DQO process conducted in support of the RI/FS process for the 200-PO-1 Groundwater OU.

4.1 SUMMARY OF THE DATA QUALITY OBJECTIVES

The *Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit* (FH 2007a) is the foundation for preparing this RI/FS Work Plan and the Characterization SAP. The purpose of the DQO process is to identify and evaluate data needs required to support the RI/FS process for the 200-PO-1 Groundwater OU. The DQO defines and evaluates data needed to define the nature and extent of contamination, complete a risk assessment, evaluate remedial action alternatives, and implement long-term monitoring of completed remedial actions.

This Work Plan and both SAPs reflect the routine monitoring and the characterization needed to support an RI/FS investigation. Related studies for the 200-PO-1 Groundwater OU have included the *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit* (DOE/RL 1997a), the *RCRA Corrective Measures Study for the 200-PO-1 Operable Unit* (DOE/RL 1997c), and the 200 East Groundwater AAMSR (DOE/RL 1993c). The current understanding of groundwater quality for selected contaminants in the 200-PO-1 Groundwater OU is reflected in PNNL 2007.

The overall goal of the DQO process is to develop a sampling design that will either confirm or reject the conceptual site model (CSM) developed in the DQO process. The CSM is continuously refined as additional data become available. The current CSM is presented in Section 5.3.2.

4.1.1 Sampling and Analysis Plan for Routine Monitoring

The Monitoring SAP was prepared and approved in 2005 to provide groundwater data necessary to track the extent and concentration of groundwater contaminant plumes, and develop a CSM. The Monitoring SAP is provided by electronic reference in Appendix B for informational purposes. The data are required for RI/FS scoping under the CERCLA, 40 CFR 300.430(b), "Remedial Investigation/Feasibility Study and Selection of Remedy," and Site-wide surveillance monitoring under the AEA.

The Monitoring SAP describes groundwater sampling and analysis requirements for the 200-PO-1 Groundwater OU. It specifies wells and aquifer sampling tubes to be monitored, constituents to be analyzed, and frequency of sampling. The Monitoring SAP organizes the wells by their proximity to the sources of the major contaminant plumes in the 200 East Area. Wells located near the plume sources are termed near-field wells, and wells farther from sources are far-field wells.

4.1.2 Sampling and Analysis Plan for Characterization

The Characterization SAP is prepared to further characterize the 200-PO-1 Groundwater OU through additional data collection efforts. The Characterization SAP presents a multi-faceted program for characterization of the 200-PO-1 Groundwater OU beyond what is currently presented in the Monitoring SAP. The data acquisition program is designed to complement the Monitoring SAP, and is intended to yield new information regarding groundwater flow direction and rates, preferential pathways for contaminant migration, and contaminant mass transport. Some aspects of the Characterization SAP will supplement site-specific VZ characterization efforts for the purpose of estimating future threats to groundwater quality from existing VZ contamination.

The Characterization SAP encompasses field methods other than those routinely applied for groundwater monitoring at the Hanford Site. The general objectives of the characterization program include the following:

- Refine the water table map of the southern portion of the 200 East Area (to help determine groundwater flow direction) by resurveying well locations and elevations, correcting depth to water measurements through checking well verticality, and performing a trend surface analysis which will help determine regional trends.

- Estimate the three-dimensional distribution of groundwater contaminants and aquifer properties through depth-discrete sampling and analysis, depth-discrete hydrologic testing, and geophysical estimation of flow parameters.

- Apply various geophysical methods to identify structural and stratigraphic features that could influence contaminant migration and groundwater flow in the unconfined and confined aquifers.
- Apply single-well geochemical tracer methods or alternative instrumental methods to map hydraulic conductivity (and relative flow velocity) in monitoring wells.
- Complete electrical resistivity geophysical characterization at selected waste sites to estimate the lateral and vertical extent of electrically conductive contaminants in the VZ.

The end products of the 200-PO-1 Groundwater OU RI/FS are an estimate of human health and environmental risks that are posed by groundwater contaminants, and an evaluation of available remedial methods in terms of achievable risk reduction and realistic economics. The Monitoring SAP and Characterization SAP data are expected to provide a sufficient basis for required risk estimates, groundwater fate and transport modeling, and further refinement of the CSM for the 200-PO-1 Groundwater OU. The data also will serve as a basis for evaluating remedial methods and estimating the rate of groundwater and contaminant transport to potential receptors such as the Columbia River.

4.2 NATURE AND EXTENT OF CONTAMINATION

4.2.1 Historic Contaminant Research

This section presents the results of a formal COPC evaluation. Emphasis is on the development of a list of COPC in the groundwater of the 200-PO-1 Groundwater OU. The evaluation presented here is an emulation of prior COPC evaluations conducted in both the 200-ZP-1 and 200-UP-1 OUs.

The COPC list was developed in two steps. First, existing documents were examined to prepare a comprehensive list of radionuclides and hazardous chemicals disposed of or used in processes at facilities within the 200-PO-1 Groundwater OU, as well as in the neighboring 200-BP-5 Groundwater OU and the BC Cribs and Trenches Area. A total of 339 potential contaminants were discovered.

Second, the HEIS database was queried for the period November 1, 1988, to November 1, 2006, for 189 wells within the 200-PO-1 Groundwater OU. The purpose of the query was to evaluate analytical results for the 339 potential contaminants discovered in the first step, above, and an additional 257 potential contaminants for which analytical data are recorded in the HEIS database. The query yielded a list of 44 COPCs in the following two categories:

- Groundwater contaminants with concentrations greater than state and/or Federal MCLs
- Potential contaminants for which no analytical data were available, and which could therefore, not be excluded.

The 44 COPCs that are a product of the formal evaluation are shown in Section 4.2.3.3.

Step I

All references to documents cited in this section are located in Appendix D. Step I research consisted of examining existing documentation for any constituents that were known or believed to be used within processes at or within the general areas of the 200-PO-1 Groundwater OU. Six documents provided the bulk of COPCs, while 19 others provided ancillary constituents. The majority of the historical information regarding COPCs was located in the following historic process documents:

- DOE/RL 1993a, *PUREX Plant Source Aggregate Area Management Study Report*, DOE/RL-92-04, Rev. 0
- DOE/RL 1993c, *200 East Groundwater Aggregate Area Management Study Report*, DOE/RL-92-19, Rev. 0
- DOE/RL 1997a, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*, DOE/RL-95-100, Rev. 1
- DOE/RL 1996a, *200-PO-1 Operable Unit Permit Modification*, DOE/RL-96-59, Draft A
- DOE/RL 1997c, *RCRA Corrective Measures Study for the 200-PO-1 Operable Unit*, DOE/RL-96-66, Rev. 1
- DOE/RL 2000, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*, DOE/RL-99-07, 2000, Rev. 0.

Various documents listed below provide data on adjacent areas, which include the 200-BP-5 Groundwater OU, Tank Farms, and the BC Cribs and Trenches Area waste sites. Each of the historic process documents presents nonradioactive and radioactive constituents from those waste sites. In addition, constituents from routine monitoring were included in the initial list of COPCs.

- DOE/RL 2005b, *Feasibility Study for the BC Cribs and Trenches Area Waste Sites Hanford Site, Richland, Washington*, DOE/RL-2004-66, Draft A
- FH 2007b, *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*, WMP-29845, Draft A
- CHG 2003, *Subsurface Conditions Description of the C and A-AX Waste Management Area*, RPP-14430, Rev. 0
- CHG 2006, *Geology, Hydrology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*, RPP-23748, Rev. 0.

4.2.2 Routinely Monitored Contaminants of Potential Concern

Bands of guard wells, chosen from the monitoring well network of the 200-PO-1 Groundwater OU, were previously established in the Monitoring SAP (DOE/RL 2005a). These guard wells (shown in Figure 4-1) consist of two bands of wells that are sampled at a minimum annually, and are used to detect and monitor plumes emanating from waste sites in the 200-PO-1 Groundwater OU. One band, the Southeast Transect, is located to the south and east of the 200 East Area and detects contamination moving into the southern and eastern parts of the Hanford Site from the 200-UP-1 OU to the 200-PO-1 Groundwater OU. A second band, the River Transect, is positioned along the Columbia River at the eastern edge of the Hanford Site to monitor contaminant transport into the Columbia River.

For the purposes of this report, the 200-PO-1 Groundwater OU is divided into three geographic areas of concern (see Figure 4-1). The near-field region represents source areas within and adjacent to the 200 East Area, and downgradient to and including the SE Transect wells. The far-field region is defined as the area of the 200-PO-1 Groundwater OU extending from the SE Transect wells to the Columbia River. The River Transect wells, a subset of the far-field region, represents the final area of concern.

The far-field groundwater contaminants are tritium, I-129, and nitrate. Concentrations of nitrate that exceed the 45 mg/L drinking water standard as nitrate, or 10 mg/L as nitrogen in nitrate, and I-129 that exceed the minimum required detection level, are within the 2000 pCi/L tritium boundary isopleths (PNNL 2007). Near-field monitoring is associated primarily with TSD facilities, but includes the BC Cribs and Trenches Area. The near-field contaminant plumes are generally localized and of limited area.

Table 4-1 presents a list of routinely sampled analytes and parameters for near field, far field, and supplementary wells, and the routine monitoring requirements for the combined RCRA, CERCLA, and AEA groundwater monitoring well network (FH 2003b). Supplementary wells are monitored under monitoring plans other than the 200-PO-1 Groundwater OU plan, such as RCRA and WAC permit plans.

Tables 4-2 and 4-3 identify the 339 nonradiological and radiological COPCs, respectively, that were identified from Step I.

Figure 4-1. Location of the Near Field, Far Field, Southeast, and River Transects.

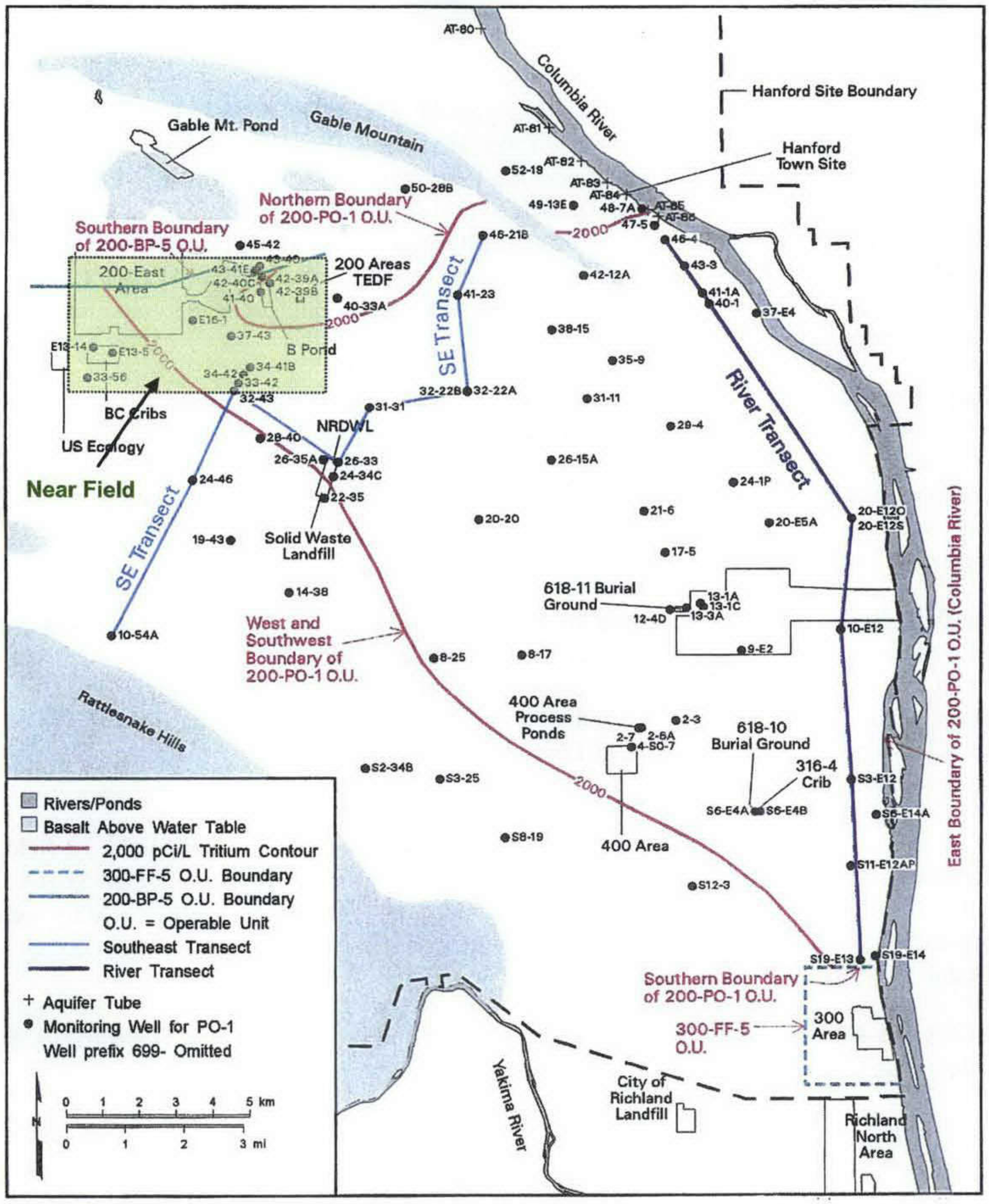

Table 4-1. Routinely Monitored Constituents in the 200-PO-1 Groundwater Operable Unit.

Contaminant of Potential Concern	Near-Field Wells[a]	Far-Field Wells[b]	Supplementary Wells[c]
Alkalinity			x
Anions	x	x	x
Arsenic	x	x	x
Chromium	x		
Cyanide		x	x
Gross alpha	x	x	x
Gross beta	x	x	x
Gross gamma		x	x
Hexavalent chromium		x	x
Inductively coupled plasma metals		x	x
Iodine-129	x	x	x
Lead		x	x
Manganese	x		
Mercury		x	x
Metals	x		
Nitrate	x	x	
Phenols			x
Specific conductance	x	x	
Strontium-90	x	x	x
Technetium-99	x	x	x
Temperature	x	x	
Total dissolved solids			x
Total organic carbon		x	x
Total organic halides		x	x
Tritium	x	x	x
Turbidity	x	x	
Uranium		x	x
Vanadium	x		
Volatile organic analyte		x	x

[a]Routinely sampled analytes and parameters for near-field wells.
[b]Routinely sampled analytes and parameters for far-field wells.
[c]Routinely sampled analytes and parameters for supplementary wells. Supplementary wells are monitored under monitoring plans other than the 200-PO-1 Groundwater Operable Unit plan such as *Resource Conservation and Recovery Act of 1976* and *Washington Administrative Code* permit plans.

Table 4-2. Initial Comprehensive List of Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Metals	Other Inorganics	Semivolatiles
Aluminum	Ammonia	2,3,4,6- Tetrachlorophenol
Aluminum nitrate monobasic	Ammonium carbonate	2,4-Dichlorophenol
Aluminum nitrate nonahydrate	Ammonium fluoride	2,4-Dichlorophenoxyacetic acid 2,4-D
Antimony	Ammonium ion	2,4-Dimethylphenol
Arsenic	Ammonium nitrate	2,4-Dinitrophenol
Barium	Hydrazine	2,4-dinitrotoluene
Beryllium	Hydrobromic acid	2-methylphenol (o-cresol)
Bismuth	Hydrochloric acid	2-Nitrophenol
Bismuth phosphate	Hydrofluoric acid	Dinoseb 2-sec Butyl-4,6-dinitrophenol
Boron	Hydrogen peroxide	3-Methylphenol
Cadmium	Hydroxylamine hydrochloride	4-methylphenol (p-cresol)
Cadmium nitrate	Hydroxylamine nitrate	Benzo [a] anthracene
Ceric fluoride	Nitric acid	Benzo [a] pyrene
Ceric sulfate	Periodic acid	Benzo[b] fluoranthene
Cerium	Phosphoric acid	Benzo [k] fluoranthene
Chromium	Phosphorus	Bis (2-ethylhexyl) phthalate
Cobalt	Phosphorus pentoxide	Butylated hydroxy toluene
Copper	Sodium bisulfate	Chlorobenzene
Ferric nitrate	Sodium bromate	Chrysene
Ferrocyanide	Sodium carbonate	Dibenzo [a,h] anthracene
Ferrous sulfamate	Sodium dichromate	Dibutyl butyl phosphonate
Ferrous sulfate	Sodium ferrocyanide	Dibutyl phosphate
Gold	Sodium fluoride	Diethylphthalate
Hexavalent chromium	Sodium hydroxide	Di-n-Butylphthalate
Iron	Sodium nitrate	Hydroxyacetic acid
Lanthanum	Sodium nitrite	Indeno [1,2,3-cd] pyrene
Lanthanum fluoride	Sodium sulfate	Monobutyl phosphate
Lanthanum hydroxide	Sodium thiosulfate	Naphthylamine
Lanthanum nitrate	Sulfamic acid	n-butyl benzene
Lead	Sulfuric acid	N-Nitrosodiphenylamine
Lead nitrate	Thiocyanate	Polychlorodibenzodioxin
Lithium	**Volatile Organics**	Polychlorodibenzofuran
Magnesium	1,1,1-Trichloroethane	Tetrachlorophenol
Manganese	1,1,2,2-Tetrachloroethane	Thenoyltrifluoroacetone
Mercury	1,1-Dichlorethane	Tributyl phosphate
Mercuric nitrate	1,2-Dichlorobenzene	Trichlorophenol

Table 4-2. Initial Comprehensive List of Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Metals	Volatile Organics	Semi-volatiles
Molybdenum	1,2-Dichloroethane	Tri-n-dodecylamine
Nickel	1,3-Dichlorobenzene	Tris-2-chloroethyl phosphate
Nickel nitrate	1,4-Dichlorobenzene	**Hydrocarbons**
Potassium	1-Butanol, butyl alcohol	Decane
Potassium fluoride	1-Butynol	Diesel fuel
Potassium hydroxide	2-Butanone	Dodecane
Potassium oxalate	2-Chlorophenol	Hydraulic fluids (greases)
Potassium permanganate	2-Hexanone	Kerosene
Radium	2-Propanol (Isopropyl alcohol)	Lard oil
Selenium	4-Chloro 3-methylphenol	Paint thinner
Selenium tetroxide	4-Methyl-2-Pentanone (Hexone)	Paraffin hydrocarbons NPH
Silicon	Acetone	Shell E-2342 (naphthalene and paraffin)
Silicon trioxide	Acetonitrile	Soltrol-170 (purified kerosene)
Silver	Benzene	**Pesticides**
Silver nitrate	Bromodichloromethane	2,4,5-TP Silvex
Sodium	Carbon disulfide	4,4'-DDD
Strontium	Carbon tetrachloride	4,4'-DDE
Thallium	Chloroform	4,4'-DDT
Tin	cis-1,2-Dichloroethylene	Aldrin
Titanium	Cyclohexane	Alpha BHC
Tungsten	Cyclohexanone	Delta- BHC
Tungsten tetroxide	Dibromochloromethane	Dieldrin
Uranium	Diethyl ether	Dimethoate
Vanadium	Ethanol	Endosulfan sulfate
Zinc	Ethylbenzene	Endrin
Zirconium	Ethylene glycol	Endrin aldehyde
Zirconium oxide	Ethyl cyanide	Heptachlor
Zirconyl phosphate	Formaldehyde	Heptachlor epoxide
Miscellaneous	Hexane	Lindane (Gamma BHC)
Aroclor-1254*	Methyl chloride	Methoxychlor
Aroclor-1260*	Methylene chloride	Phorate
Polychlorinated biphenyls	Naphthalene	Toxaphene
Sugar	Pentachlorophenol	**Anions**
Complexants	Phenol	Bromide
Citrate	Phenols	Chloride
EDTA	Pyrene	Cyanide

Table 4-2. Initial Comprehensive List of Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Glycolate (Hydroxyacetic acid)	Tetrachloroethene	Fluoride
HEDTA	Tetrahydrofuran	Hydroxide
Complexants	**Volatile Organics**	**Anions**
Oxalic acid	Toluene	Nitrate
Tartaric acid	trans-1,2-Dichloroethylene	Nitrite
Water Quality Measurements	Trichloroethane	Oxalate
Alkalinity	Trichloroethene	Perchlorate
Coliform bacteria	Trichloromonofluoromethane	Phosphate
pH	Vinyl chloride Trichloromonofluoromethane	Sulfate
Specific conductance	Xylene	Sulfide
Temperature		
Total organic carbon		
Turbidity		

*Aroclors also are a subset of polychlorinated biphenyls.
Aroclor is an expired trademark.

Table 4-3. Initial Comprehensive List of Radiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit. (2 Pages)

Actinium-225	Gamma scan*	Radium-228
Actinium-227	Gross alpha*	Radon-220
Americium-241	Gross beta*	Radon-222
Americium-242	Iodine-129	Rhodium-106
Americium-242m	Iodine-131	Ruthenium-101
Americium-243	Lead-209	Ruthenium-103
Antimony-125	Lead-210	Ruthenium-106
Antimony-126	Lead-211	Samarium-151
Antimony-126m	Lead-212	Selenium-79
Astatine-217	Lead-214	Strontium-90
Barium-137m	Manganese-54	Technetium-99
Beryllium-7	Neptunium-237	Thallium-207
Bismuth-210	Neptunium-239	Thallium-208
Bismuth-211	Nickel-63	Thorium-227
Bismuth-212	Nickel-64	Thorium-229
Bismuth-213	Palladium-107	Thorium-230
Bismuth-214	Plutonium-238	Thorium-231

Table 4-3. Initial Comprehensive List of Radiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit. (2 Pages)

Carbon-14	Plutonium-239/240	Thorium 232
Cerium/ Praseodymium-144	Plutonium-241	Thorium-233
Cesium-134	Polonium-210	Thorium-234
Cesium-135	Polonium-213	Tin-113
Cesium-137	Polonium-214	Tin-126
Chlorine-36	Polonium-215	Tritium
Cobalt-58	Polonium-218	Uranium-233
Cobalt-60	Potassium-40	Uranium-234
Curium-242	Promethium-147	Uranium-235
Curium-244	Protactinium-231	Uranium-238
Curium-245	Protactinium-233	Yttrium-90
Europium-152	Protactinium-234	Zinc-65
Europium-154	Radium-223	Zirconium-93
Europium-155	Radium-224	Zirconium/Niobium-95
Francium-221	Radium-225	
Francium-223	Radium-226	

*Represents survey parameters.

4.2.3 Contaminants of Potential Concern Evaluation

4.2.3.1 Step II

To examine the levels of current groundwater contamination and evaluate the concentrations of COPCs as a function of time and location, the HEIS database was queried. Contaminant analyses were downloaded for all wells within the 200-PO-1 Groundwater OU from November 1, 1988, to November 1, 2006, for evaluation. A total of 189 wells were included in the database download. The resulting data included information on the following types of constituents: metals, non-metals, ions, water quality parameters, polychlorinated biphenyls and pesticides, radiological, semivolatile organic compounds, and volatile organic compounds. The results of each constituent were evaluated by comparing individual contaminant results to a selected PRG.

Screening values were extracted for all constituents (when available) from the following sources: the *Cleanup Levels & Risk Calculations* (CLARC) database (Ecology 2005) for carcinogen and non-carcinogen values, primary and secondary MCLs from EPA's National Drinking Water Standards, PRGs defined in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE/RL 2001a), and background levels from *Hanford Site Groundwater Background* (DOE/RL 1992b). If the background value was higher than any PRG available, the background value was used.

4.2.3.2 Contaminant Inclusion/Exclusion Evaluation Process

The logic for inclusion/exclusion is presented below. The output from the evaluation process is available electronically on request. Tables E1-3 and E1-4 in Appendix E present all of the nonradiological and radiological COPCs and the justifications for either the inclusion or exclusion of the COPCs.

The following logic was applied for nonradiological COPCs.

- If the constituent was listed, it was examined in the CLARC database, the *Integrated Risk Information System* (IRIS) database (maintained by EPA) and the *Agency for Toxic Substances and Disease Registry* database to list both carcinogenic and toxic constituents. If the IRIS database indicated that it was neither carcinogenic nor toxic, then it was not included as a COPC.

- Parameters that are not specific compounds and that provide no specific risk information (e.g., pH or total organic carbon were excluded from the formal CERCLA COPC list. In some cases, these analyses will be performed on selected wells to assist in groundwater modeling.

- If the constituent has a PRG from the following criteria it was included in the formal evaluation:

  - The primary or secondary MCL for drinking water specified by EPA

  - The cleanup levels for groundwater as provided in the CLARC database as based on WAC 173-340-720(4), "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water," and WAC 173-340-720(5), "Method C Cleanup Levels for Potable Ground Water," for non-carcinogenic risks

  - The cleanup levels for groundwater as provided in the CLARC database as based on WAC 173-340-720(4) and WAC 173-340-720(5) for carcinogenic risks

  - The groundwater background threshold value, as listed in DOE/RL 1992b, Table 5-9, and the PRGs as defined in DOE/RL 2001a.

For the radiological COPCs, any radionuclide on the list with a half-life of less than 2 years was not included. Similarly, natural short-lived daughter products of other radionuclides in the list were discarded because the daughter products are considered in any calculation of dose from the parent isotopes.

For the remaining constituents, the analytical results from all 200-PO-1 Groundwater OU analyses in the HEIS database were compared for all COPCs with PRGs. If any detected result for a constituent exceeded the set PRG, it was retained as a COPC, unless the following occurred:

- The analytical result was flagged with a "P" or "Q" (flags represent that during data validation, the reviewer believed there was a potential problem "P," with the data or the associated QC, or "Q" data), and subsequent analyses were consistently below PRGs. The "P" may reflect that the reviewer believed there may have been a problem with the collection/analysis circumstances that makes the value questionable. The "Q" may reflect that the reviewer found that an associated quality control value was out of limits.

- Subsequent analyses of the well(s) that had exceedances for the particular constituent show results consistently below the PRG.

A total of 596 COPCs were addressed from Steps I and II. Only 235 COPCs had set PRGs and were formally evaluated. The results for the 235 constituents were compared against the PRGs. Any result for a constituent that had a detected exceedance above the PRG was included on the candidate list of COPCs. Of the 235 with PRGs, 179 did not have any detects that exceeded PRGs, and were thus excluded from further consideration. Of the remaining 56 COPCs, 12 were excluded due to questionable analytical results, chemical properties, and also had subsequent analyses that were consistently below the PRGs. Hydrazine and phosphorus were removed from further consideration. Hydrazine is very reactive in water and has been shown to disassociate, and phosphorus is analyzed as phosphate. These 12 constituents and the reasons for exclusion are shown in Table 4-4.

Table 4-4. Analytes Excluded.

Reasons for Exclusion	Analytes Excluded
Analytical Results were reported as questionable, or suspect based on quality control issues and illogical results	4,4'-DDT, Aldrin, Dinoseb, Endrin, Lindane, Barium, Beryllium, Silver, Aniline
Only one or few detects exceeded in one or more wells, and subsequent results from the same well or wells show that values are below preliminary remediation goals	4,4'-DDT, Aldrin, Dinoseb, Endrin, Lindane, Barium, Beryllium, Silver, 2,4-Dichlorophenol, Aniline
Compound reactive in water, not expected to persist	Hydrazine
Covered as phosphate; see Table E1-3 in Appendix E.	Phosphorus

4.2.3.3 Proposed List of Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit

Table 4-5 presents the proposed list of 44 COPCs within the 200-PO-1 Groundwater OU. Tables E1-3 and E1-4 in Appendix E present all of the nonradiological and radiological contaminants and the justifications for either the inclusion or exclusion of each as a COPC.

Table 4-5. Proposed List of Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit.

Metals	Semivolatile Organic Compounds
Antimony	2,4-Dinitrophenol
Arsenic	Bis (2-ethylhexyl) phthalate
Cadmium	Nitrobenzene[b]
Chromium	Pentachlorophenol
Lead	**Radiological**
Manganese	Gross alpha[c]
Nickel	Iodine-129
Thallium	Neptunium-237[a]
Uranium	Protactinium-231[a]
Vanadium	Selenium-79[a]
Zinc	Strontium-90
Volatile Organic Compounds	Technetium-99
1,1,2,2-Tetrachloroethane	Tritium
1,2-Dichloroethane	Uranium-234
1,4-Dioxane[b]	Uranium-238
Benzene	**Pesticides**
Bromodichloromethane	Dieldrin
Carbon tetrachloride	Dimethoate
Dibromochloromethane	Heptachlor
Hexane[a]	Heptachlor epoxide
Methylene chloride	**Ions**
Tetrachloroethene	Fluoride
Trichloroethene	Nitrate
Vinyl chloride	Nitrite

[a]Represents constituents found in historical process documents that have a potential to contribute to dose and have long half lives, or in the case of hexane, regulatory limits set due to U.S. Environmental Protection Agency listing as a possible carcinogen; these contaminant of potential concerns have not been previously analyzed in the 200-PO-1 Groundwater Operable Unit.

[b]Represents constituents not found in historical process documents, but are found in the 200-PO-1 Groundwater Operable Unit.

[c]Represent survey parameters.

4.3 CONTAMINANTS OF POTENTIAL CONCERN AND WELL SELECTION

In addition to the evaluation of COPCs presented, the well selection for sampling and analysis include the activities discussed in Sections 4.3.1 through 4.3.3 of this Work Plan.

A two-phased approach is planned to complete RI activities for the 200-PO-1 Groundwater OU (see Table 4-6). This will include any geophysical and geotechnical information that has already been established (Sections 4.3.2 and 4.3.3).

Table 4-6. Summary of Phase I and Phase II Characterization Activities.

Phase I and Phase II		
Characterization Activities	All wells and frequencies shown in Tables A3-1 and A3-2 of Appendix A	
Routine Monitoring Activities	All Wells and frequencies shown in Tables 2-1 and 2-2 of Appendix B	
Phase I		
	Area	Well Identification[a]
Opportunistic Wells[b]	PUREX	A-2
		A-5
		A-30
	BC Cribs	A
		C
		E
Planned Aquifer Tubes	River Corridor	10 Sets of 3
Phase II		
	Area	Well Identification[a]
Opportunistic Wells[b]	PUREX	A-7
Planned Wells[c]	To be decided	A
		B
		C
		D

[a] Preliminary well identification is presented. Once wells are physically established, formal well names will be given.

[b] Opportunistic wells are wells that operable units outside of the 200-PO-1 Groundwater Operable Unit are proposing to drill. These offer an opportunity for supplemental data gathering.

[c] Planned wells are those that may be drilled in the 200-PO-1 Groundwater Operable Unit, but locations will depend on the data evaluation from Phase I.

PUREX = Plutonium-Uranium Extraction (Plant or process).

According to the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, OSWER Directive 9355.3-01 (EPA 1988), the RI process serves as a mechanism for collecting data to characterize site conditions; determine the nature of the waste; and assess risk to human health and the environment. The FS continues to serve as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. Data collected in the RI influence the development of remedial alternatives in the FS. The various phases of the RI/FS process provide an iterative approach to data collection. Two concepts are essential to the phased RI/FS approach.

First, data should generally be collected in several stages, with initial data collection efforts usually limited to developing a general understanding of the site. Field sampling should be phased, so that the results of the initial sampling efforts can be used to refine plans developed during scoping to better focus subsequent sampling efforts. As a basic understanding of site characteristics is achieved, subsequent data collection efforts focus on filling identified gaps in the understanding of site characteristics and gathering information necessary to evaluate remedial alternatives.

Second, this phased sampling approach encourages identification of key data needs as early in the process as possible to ensure that data collection is always directed toward providing information relevant to selection of a remedial action. In this way, the overall site characterization effort can be continually scoped to minimize the collection of unnecessary data and maximize data quality.

4.3.1 Well and Analyte Selection for Phase I and Phase II Characterization and Assessment in the *200-PO-1 Groundwater Operable Unit*

Sections 4.3.2.1 through 4.3.3 explain details of the summary information that is provided in the following paragraphs. A total of 107 wells are selected for assessment in the 200-PO-1 Groundwater OU. It is proposed that ten aquifer tubes stations be drilled in Phase I along the river corridor. An aquifer tube station consists of a set of three tubes emplaced at different depths vertically in one well casing. Each tube will be sampled for the 44 COPCs listed in Table 4-5.

In addition, six wells, three from the PUREX Area (A-2, A-5, and A-30) and three from the BC Crib and Trenches Area (A, C, and E) will be opportunistically sampled in Phase I. One well (A-7) proposed for drilling in fiscal year (FY) 2009 adjacent to the 216-A-7 crib also will be opportunistically sampled in Phase II. Opportunistic wells are wells that are drilled in other OUs, including waste sites from which 200-PO-1 Groundwater OU task leads will collect samples from to acquire supplemental data.

Four wells (A, B, C, and D) will be installed within the 200-PO-1 Groundwater OU during Phase II. The specific locations of these 4 new wells are to be determined through the Phase I data collection efforts.

The remaining eighty-six wells are existing wells that are to be added for assessment with the analytes and frequency of sampling shown in the Tables A3-2 and A3-3 of the Characterization SAP (Appendix A).

The analytes chosen in Phase I and Phase II for analyses are comprised of two categories: routine monitoring analytes, and a list of 44 analytes. The routine monitoring analytes are constituents that are routinely monitored in the 200-PO-1 Groundwater OU, are included in Tables B2-1 and B2-2 of Appendix B. The list of 44 analytes in Table 4-5 consists of constituents that were designated as COPCs from the evaluation process presented in the above sections.

4.3.2 Phase I Near Field

Characterization of the 200-PO-1 Groundwater OU will be conducted in two phases. Table 4-6 presents the characterization and routine summaries of Phase I and Phase II activities. The primary objectives for Phase I are to collect data on groundwater contaminants, acquire geophysical data to estimate vertical and lateral extent of contamination, and to refine or confirm preferred contaminant pathways. In addition, a detailed evaluation of existing monitoring data will be conducted to assess data needs to determine preliminary fate and transport of analytes in the 200-PO-1 Groundwater OU.

Groundwater and geophysical data will be acquired during Phase I. Data will be gathered in order to provide information on depth of contaminants in the aquifer, provide information on stratigraphy, define the extent of a known chromium plume, assess flow direction, well deviations, and determine depth to water measurements. Within Phase I the use of existing transducer equipment in a few chosen near-field wells will be considered as well.

Groundwater grab samples will be collected from seven new opportunistic waste site borings in the 200-PO-1 Groundwater OU that intercept the water table. Opportunistic wells allow integration with other OUs. Samples will be collected from bore holes drilled in other OUs and analyzed for the 44 COPCs. The purpose of these samples is to better define the nature, extent of contamination and movement of contaminants deep in the aquifer. The geophysical data acquired will provide information helpful for future fate and transport modeling and help locate preferential pathways for contaminant movement.

4.3.2.1 PUREX

A VZ well within the PUREX Area (299-E24-23) was drilled adjacent to the 216-A-4 Crib (see Figure 4-2). This well was deepened to basalt and was sampled for the full 44 COPCs (see Table 4-5). Sediments were sampled for geochemical and geotechnical parameters required for modeling and remedial evaluation. This well assesses whether COPCs migrated deep in an area known for high contamination.

Three wells (A-2, A-5 and A-30) are scheduled to be drilled in the 216-A-2, 216-A-5, and 216-A-30 Crib areas, respectively (see Figures 4-2 and 4-3) during Phase I. These wells will be opportunistically sampled for the constituents presented in Tables A3-2 and A3-3 in Appendix A. The plan is to extend these wells to basalt and sample groundwater for the full 44 COPCs semi-annually. The sediments also will be sampled for geochemical and geotechnical parameters that are required for modeling and remedial evaluation. These wells will help assess whether COPCs have migrated deep in the unconfined aquifer in a known area of high contamination.

The data from these wells and electrical resistivity geophysical surveys will assist in characterization of the area surrounding the 216-A-36B and 216-A-37-1 Cribs.

All wells chosen for sampling within the PUREX area will have alkalinity and ammonium (RCRA constituents) added to the COPCs as noted on well Tables A3-2 and A3-3 provided in Appendix A.

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Figure 4-2. Locations of Wells (A-2, A-4, and A-5) in the PUREX Area to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.

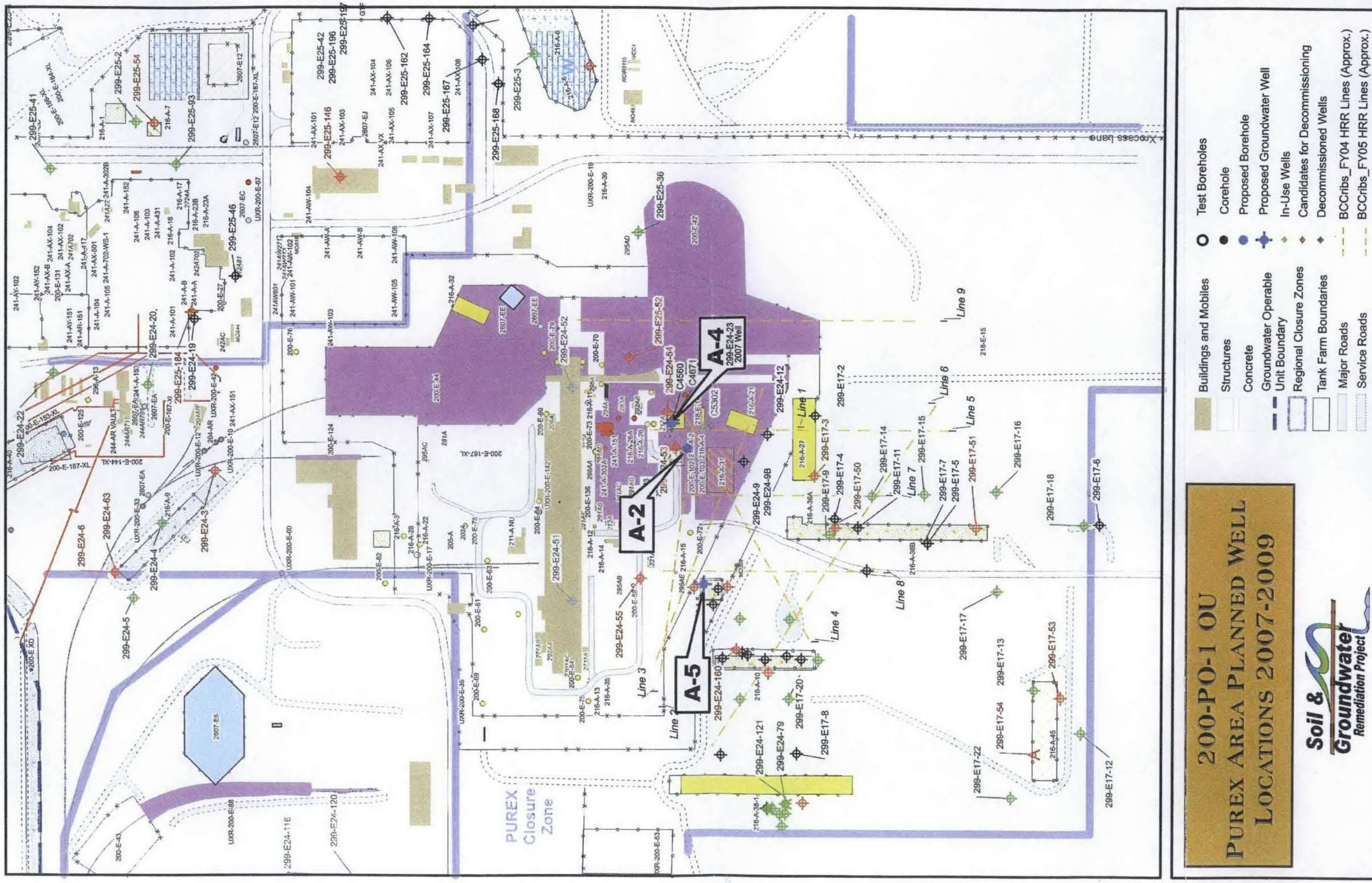
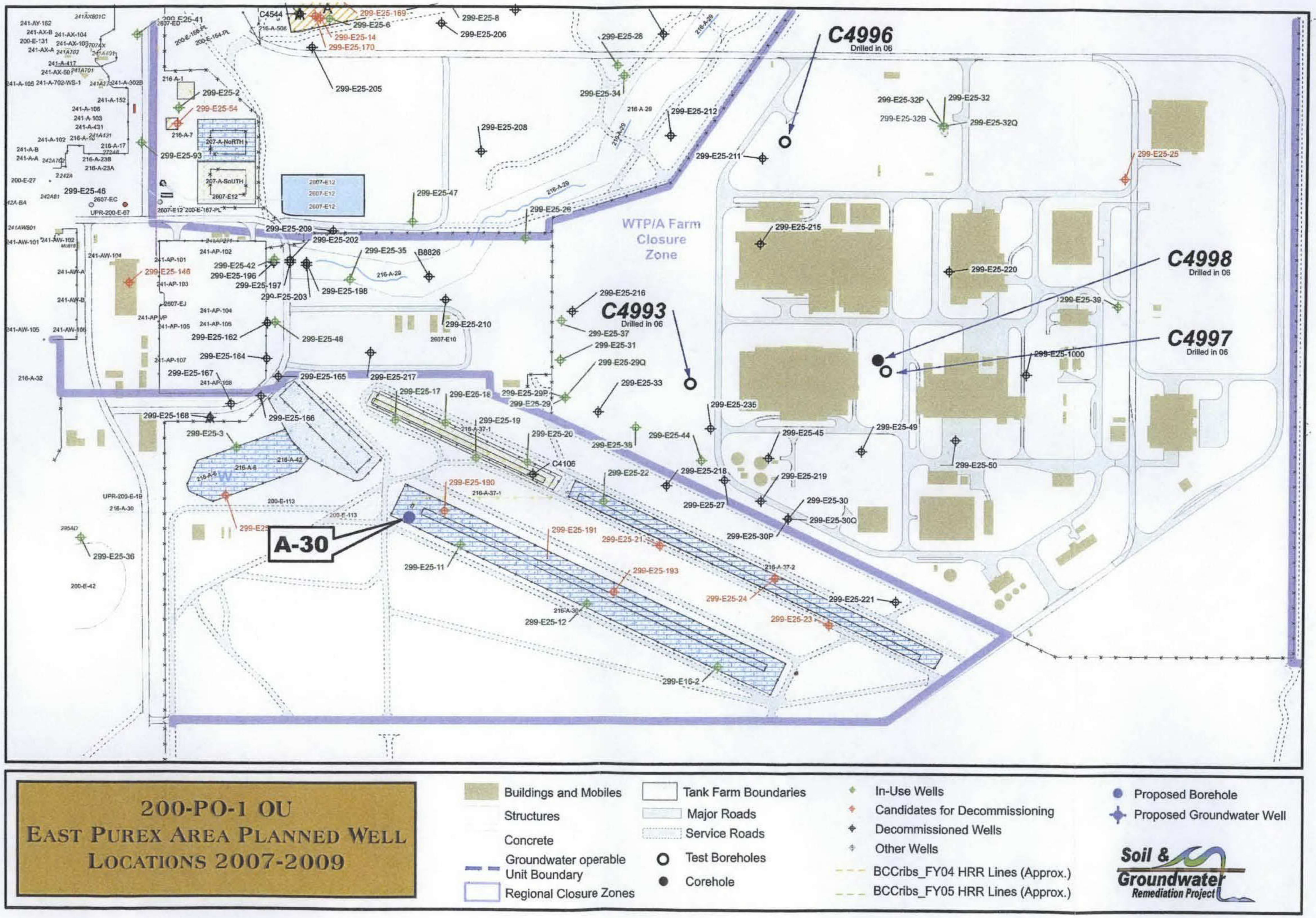


Figure 4-3. Location of Well A-30 in the PUREX Area to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.



4.3.2.2 BC Cribs and Trenches Area

A previous assessment of the capability of the BC Cribs and Trenches Area wells determined that the wells chosen are accessible and contain groundwater. Twelve wells in this area will be sampled once for the Monitoring SAP constituents. If any constituent exceedances are exhibited, the well will be sampled once more. The analytical results will be reviewed from new wells where groundwater samples are collected to determine whether additional groundwater wells are needed to assess whether any contamination has reached groundwater. Three planned wells in the BC Crib and Trenches Area (A, C, and E) are shown in Figure 4-4. The three wells will be opportunistically sampled for the full 44 analytes listed in Table 4-5. Borings B, D, C4732, and C4733, which also are proposed by the BC Cribs Waste Site OU and are shown in Figure 4-4, are outside the scope of this Work Plan.

4.3.2.3 Phase I Far-Field Tasks

Far-field is defined as the areas concerning TEDF, B Ponds, NRDWL, Solid Waste Landfill, 400 Area wells, Southeast Transect wells, and the River Transect and corridor wells. These wells will be used to collect data on groundwater contaminants, acquire geophysical data to estimate vertical and lateral extent of contamination in the aquifer, and to refine or confirm preferred contaminant pathways.

4.3.2.4 River Transect Wells

Five existing River Transect wells were chosen for sampling and analysis. These wells will have all 44 COPCs analyzed annually. These analyses will determine the extent of contamination for the purposes of risk assessment along the Columbia River.

4.3.2.5 Southeast Transect Wells

Nine existing wells were chosen along the Southeast Transect. All 44 COPCs will be analyzed annually in these wells.

4.3.2.6 Aquifer Tubes

Install and sample 10 aquifer tube stations (each station is 3 vertical tubes) along the river (see Figure A3-6 in Appendix A). Each set will be vertically placed within the upper, middle, and lower aquifer. The purpose of these new aquifer tubes is to acquire contaminant data within a geographic area that has not been acquired thus far and is needed for risk assessment, especially Ecological Risk Assessment. Coordinates of each set will be taken and markers placed within substrate for ease of relocating. More tubes may be added in Phase II if the information from the geophysical characterization suggests so.

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Figure 4-4. Location of BC Crib and Trenches Wells (A, C, and E) to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.

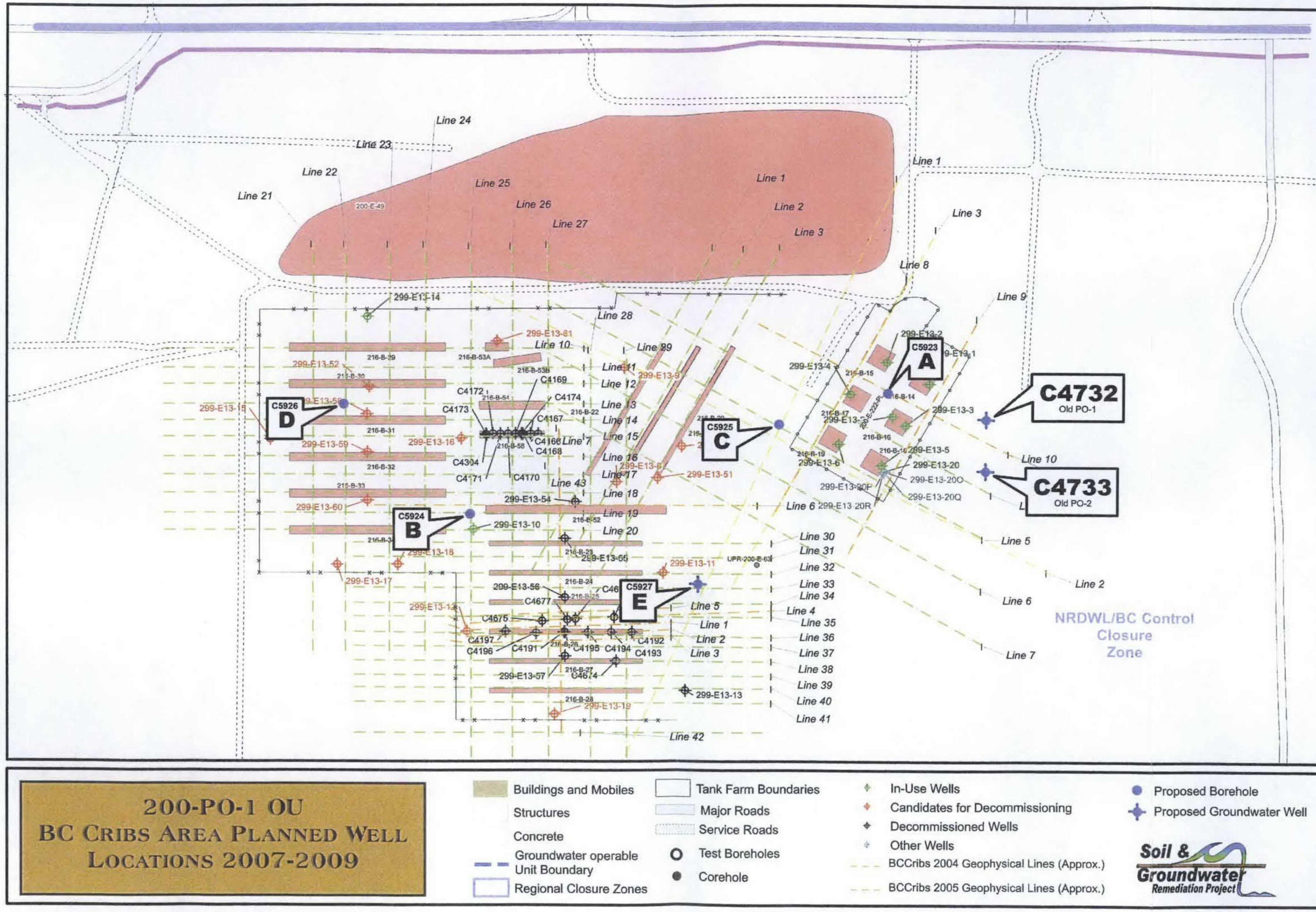
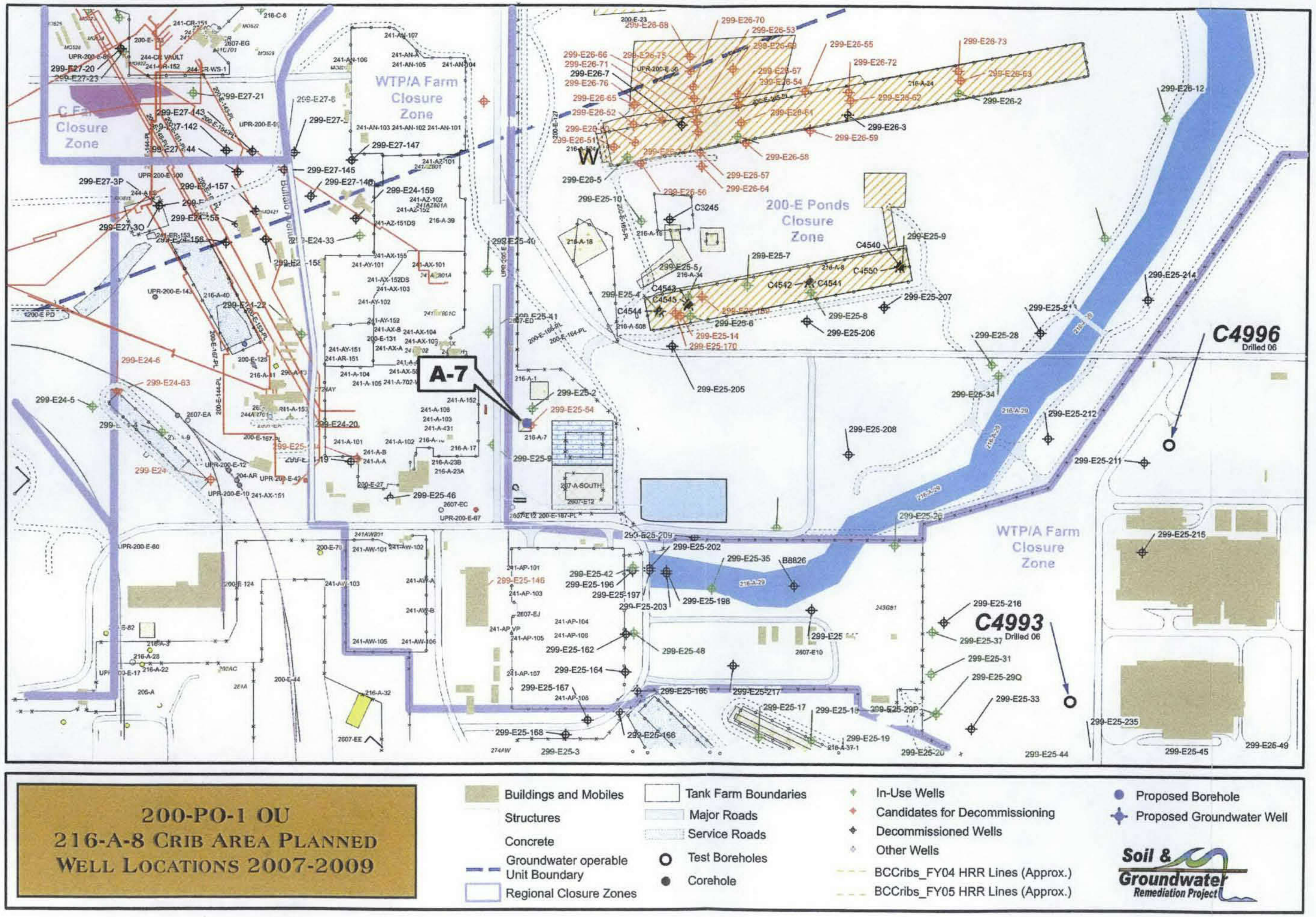


Figure 4-5. Location of PUREX Well (A-7) Adjacent to 216-A-7 Crib to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.



4.3.2.7 Candidate Wells

Forty-three candidate wells for decommissioning were selected to be evaluated for sampling utility. Any wells that are open, reasonably deep, and contain groundwater water will be logged and sampled before decommissioning. If any of the 44 COPCs exhibit exceedances the well will be sampled once more. In addition, if the wells are capable of being sampled, gradient and head data could be collected using a gyroscope to quantify water table data. It should be noted that the candidate for decommissioning wells that have been chosen for sampling may change as data becomes available on sampling utility (e.g., water availability and physical access) and as other wells are placed on the candidate list.

4.3.2.8 Nonradioactive Dangerous Waste Landfill

Samples will be collected to evaluate geophysical results to determine preferential pathways. Data from RCRA wells will be evaluated and included.

4.3.3 Phase II

Phase II objectives are to evaluate Phase I results, continue data collecting initiated in Phase I, and conduct a baseline risk assessment.

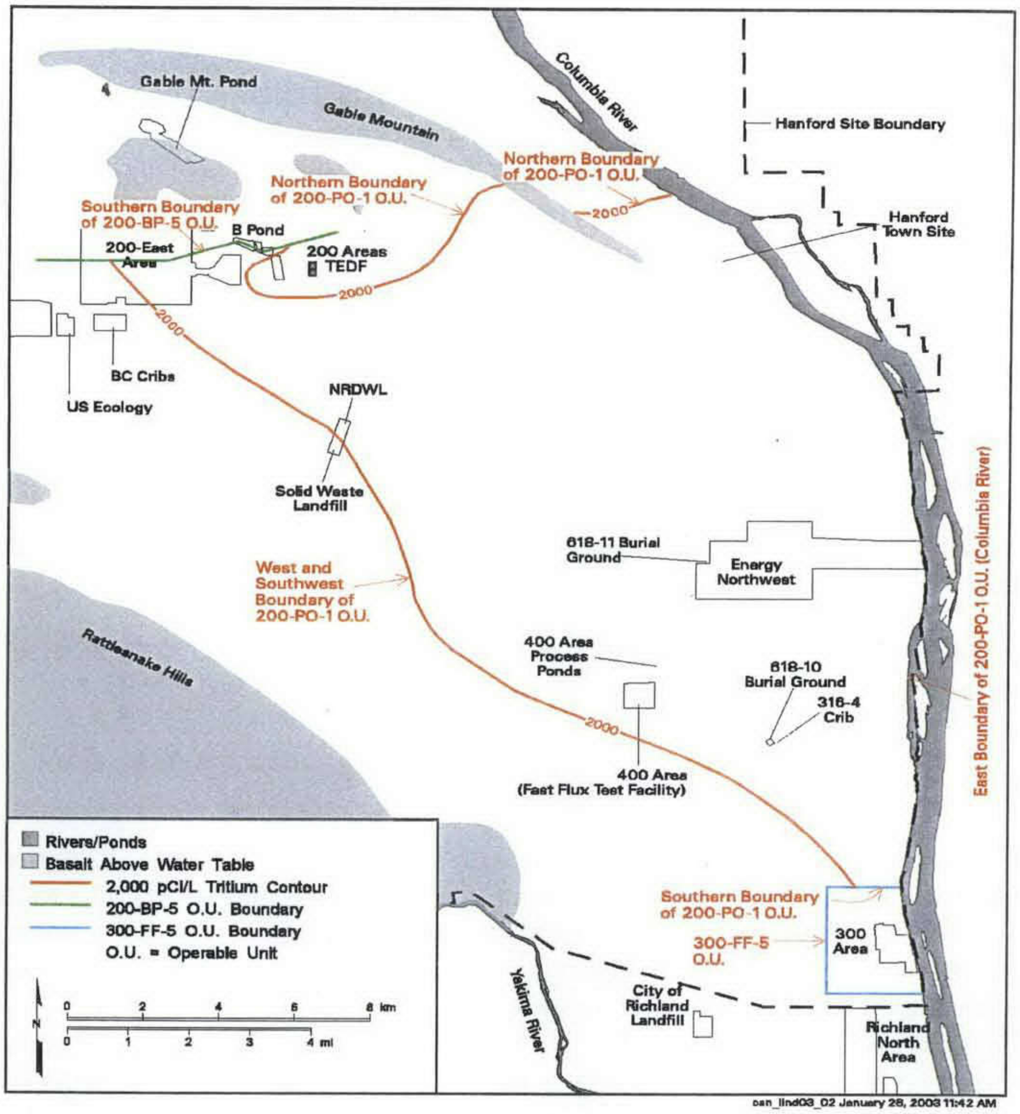
An opportunistic well (A-7) within the 216-A-7 Crib area has been selected for analysis in Phase II (see Figure 4-5).

4.4 GEOGRAPHIC AND PLUME BOUNDARIES

Figure 4-6 illustrates the geographic perimeter of the 200-PO-1 Groundwater OU representing the tritium plume that extends from the 200 East Area to the Columbia River. The western boundary is the 2000 pCi/L isopleth of tritium (one-tenth of the primary drinking water standard) on the western flank of the plume, extending from the boundary of the 300 Area on the south to the boundary between the 200-PO-1 Groundwater OU and 200-BP-5 Groundwater OU on the north. The northern boundary is the 2000 pCi/L tritium isopleth on the northern flank of the plume, extending from the Columbia River to the 200-PO-1 Groundwater OU /200-BP-5 boundary, then along the boundary to the 2000 pCi/L tritium isopleth of the western flank. The eastern boundary of the 200-PO-1 Groundwater OU is the Columbia River, south to the 300 Area. The southern boundary is represented by the northern border of the 300 Area from the river to the western 2000 pCi/L tritium isopleth.

Figure 4-6. 200-PO-1 Groundwater Operable Unit Boundaries.

Source: *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit* (DOE/RL 2005a).



4.5 SATURATED ZONE PROPERTIES

A set of specific parameters for groundwater modeling is not yet identified for the 200-PO-1 Groundwater OU. The potential modeling parameters in this section are based on those that were developed for other groundwater OUs at Hanford. Parameters such as distribution coefficient (K_d), hydraulic conductivity (K_h), particle size, and cation exchange capacity collected from completed wells are useful for modeling contaminant movement and evaluating remedial alternatives. Additional saturated zone modeling data may be obtained from new wells that are planned in the 200-PO-1 Groundwater OU. Depth-discrete groundwater data (i.e., analytical sampling and depth discrete aquifer testing) will be collected from new boreholes as they are drilled. The depth-discrete data are also useful for selecting screen intervals for new wells.

4.5.1 Saturated Zone Sediment Parameters

Specific saturated zone parameters that were considered for the 200-PO-1 Groundwater OU are listed in Table 4-7. Some of the parameters presented in Table 4-7 are to be used in fate and transport modeling and for use in evaluating remedial alternatives. The geotechnical (i.e., physical), hydraulic, and geochemical parameters are included in the *Data Quality Objectives Summary Report Supporting the 200-ZP-1 Operable Unit Remedial Investigation/Feasibility Study Process* (FH 2003c). Specific modeling requirements and the relative importance of each input will be considered before establishing a final set of modeling parameters for the 200-PO-1 Groundwater OU.

Eight potential geotechnical parameters for saturated sediments are listed in Table 4-7: particle-size distribution, geophysical borehole surveys, mineralogy, bulk density, lithology, effective porosity, specific yield, specific storage, transmissivity, hydraulic conductivity, total porosity, and bulk density. Seven geochemical parameters are listed in Table 4-7: major cations (i.e., sodium and calcium), cation exchange capacity, calcium carbonate content, K_d for carbon tetrachloride, total organic carbon, total inorganic carbon, and pH. Figure 4-7 presents the distribution of wells with hydraulic conductivity as determined from aquifer pumping tests.

The applicable geotechnical and geochemical parameters to be measured will be specified in Phase I. Details are presented in Section 5.2.

4.5.2 Groundwater Parameters

Table 4-7 lists hydraulic and geochemical parameters that maybe applicable to groundwater samples. When new wells are drilled in the 200-PO-1 Groundwater OU, some of these data will be obtained from depth-discrete groundwater samples during drilling. The project will determine whether these data are needed in preparation of Phase II. The following hydraulic parameters for groundwater modeling and/or evaluation of remedial alternatives are included: hydraulic gradient, transmissivity, K_h measured during slug tests, groundwater production rates, water-level drawdown, groundwater pumping performance during well development, and longitudinal and transverse dispersivity. Multiple depth intervals will be tested to provide an indication of the vertical distribution of hydraulic properties. The following geochemical parameters are also potential inputs for groundwater modeling and/or remedial alternatives evaluation: major cations (i.e., sodium and calcium), K_d, specific conductance, total organic carbon, total inorganic carbon, pH, temperature, alkalinity, dissolved oxygen, and turbidity. The final list of parameters will be specified in Phase I, as discussed in Section 5.2 of this Work Plan.

Table 4-7. Potential Saturated Zone Properties. (2 Pages)

Property	Parameter	Method	CRDL	Precision Required	Accuracy Required
Aquifer Sediments					
Geotechnical	Particle size distribution (by dry sieve, wet sieve, and hydrometer methods)	ASTM D422	N/A	N/A	N/A
	Borehole geophysics (neutron probe, natural gamma, spectral gamma, and gamma-gamma density[b])	[a]	N/A	N/A	N/A
	Mineralogy	XRD	N/A	N/A	N/A
	Lithology	Geologist description	N/A	N/A	N/A
	Effective porosity	Field and laboratory measurement			
	Bulk density	ASTM D2937	N/A	N/A	N/A
	Total porosity	[a]	N/A	N/A	N/A
Geochemical	Major cations (e.g., sodium and calcium)	ASTM D4327	N/A	N/A	N/A
	Cation exchange capacity	Routson et al., 1973	N/A	N/A	N/A
	Calcium carbonate content	ASTM D4373	N/A	N/A	N/A
	Total organic carbon	415.1[c]	N/A	±25%	±25%
	K_d	ASTM D3987	N/A	N/A	N/A
	Tentatively identified compound	415.1M[c]	25,000 µg C/kg sample	±25%	±25%
	pH	9045[d]	0.1 pH unit	±0.1 pH unit	±0.1 pH unit
Groundwater					
Hydraulic	Hydraulic gradient	Field measurement	N/A	N/A	N/A
	Slug test, slug interference test, constant rate discharge test, or tracer test	Field test	N/A	N/A	N/A
	Water production flow rate	Well development	N/A	N/A	N/A
	Water-level changes (drawdown)	Well development	N/A	N/A	N/A
	Groundwater pumping performance	Well development	N/A	N/A	N/A
	Dispersivity[f]	Field tracer measurement	N/A	N/A	N/A

Table 4-7. Potential Saturated Zone Properties. (2 Pages)

Property	Parameter	Method	CRDL	Precision Required	Accuracy Required
Geochemical	Major cations (e.g., sodium and calcium)	ASTM D4327	N/A	N/A	N/A
	K_d (e.g., carbon tetrachloride)	ASTM D3987	N/A	N/A	N/A
	Specific conductivity	Field screening	N/A	N/A	N/A
	Total organic carbon	415.1[c]	1,000 μg/L	±25%	±25%
	Tentatively identified compound	415.1M[c]	1,000 μg/L	±25%	±25%
	pH	9045[d]	0.1 pH unit	±0.1 pH unit	±0.1 pH unit
	Temperature	Field screening	N/A	± 1°C	1°C
	Alkalinity	310.1[c] or 310.2[c]	10 mg/L as CO_3	±20%	±25%
	Dissolved oxygen	Field screening	N/A	0.1 mg/L	±1%
	Turbidity	Field screening	<5 NTU	N/A[e]	N/A[e]

[a]Method will be defined by technical support prior to implementation.

[b]If gamma-gamma density probe is not available at the time of logging, proceed running only natural and neutron-induced capture gamma-ray spectroscopy.

[c]From *Methods for Chemical Analysis of Water and Wastes* (EPA/600/4-79/020) (EPA 1983).

[d]From *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-B*, SW-846 (EPA 2005).

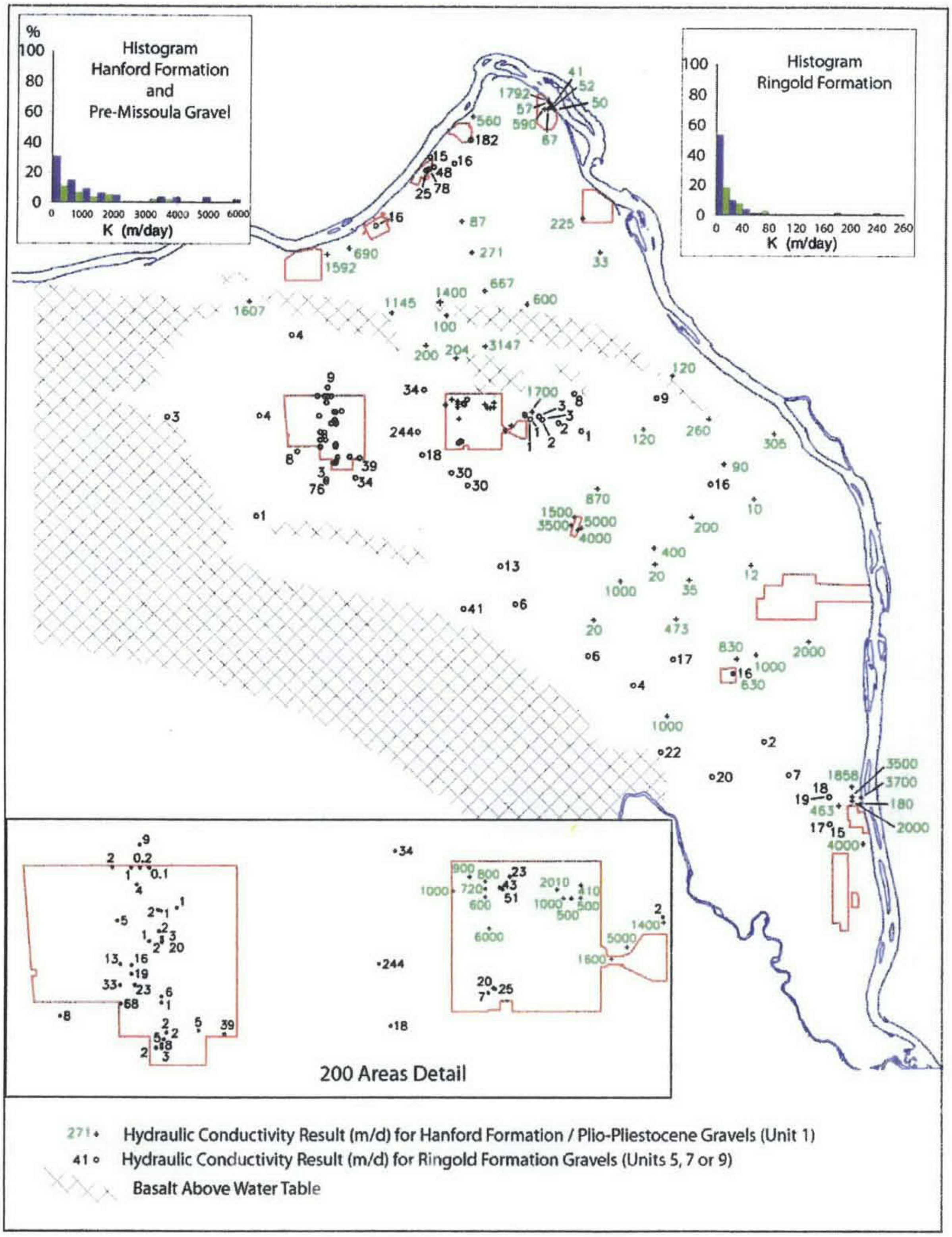
[e]Requirements are "Yes/No" above or below 5 NTU; precision and accuracy do not apply.

[f]Depending on the model grid size, dispersivity may not be needed.

ASTM D422-63 (2002)e1, *Standard Test Method for Particle-Size Analysis of Soils.*
ASTM D2937, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*
ASTM D3987-06, *Standard Test Method for Shake Extraction of Solid Waste with Water.*
ASTM D4327-03, *Standard Test Method for Anions in Water by Chemically Suppressed Ion Chromatography.*
ASTM D4373-02, *Standard Test Method for Rapid Determination of Carbonate Content of Soils.*
Routson, R. C., R. W. Wildung, and R. J. Serne, "A Column Cation-Exchange-Capacity Procedure for Low-Exchange Capacity Sands."

ASTM = American Society for Testing and Materials.
CRDL = contract-required detection limit.
K_d = distribution coefficient.
N/A = not applicable.
NTU = nephelometric turbidity unit.
XRD = X-ray diffraction.

Figure 4-7. Distribution of Wells with Hydraulic Conductivity Determined from Aquifer Pumping Tests (PNNL 2001).



5.0 REMEDIAL INVESTIGATION TASKS

5.1 INTRODUCTION

This chapter includes a summary of the tasks within each characterization phase. In addition, this chapter summarizes the conceptual model as it currently stands. The model will be updated as data are gathered and compiled.

5.2 SUMMARY OF PHASED INVESTIGATION AND CHARACTERIZATION TASKS

This project includes tasks that will be performed in phases in accordance with EPA guidance. The information gathered during a phased characterization effort supports the development of an RI/FS and an ultimate groundwater remedial decision. This Work Plan proposes a Phase 1 and Phase II remedial investigation approach as described in Table 5-1. The wells to be characterized for each phase are detailed in Section 4.3 and in Appendix A. The schedule is presented in Chapter 7.0 of this document. The general summary of the tasks are included below. Note that the sequence of the tasks within a phase may be altered. This text presents the major focus of the tasks.

Table 5-1. Overview of the Phases and Tasks for the Generation of the Remedial Investigation/Feasibility Study for 200-PO-1 Groundwater Operable Unit. (2 Pages)

Phase	Task	Description of Work
I	A	On-going characterization sampling based on Table 4-6, Phase I (as detailed in Appendix A, Characterization SAP), includes analytical characterization and slug tests on new wells. Conduct opportunistic aquifer sampling of planned waste site or research investigation boreholes as available. Collect 2 years of sampling information from an expanded list of monitoring wells to include additional wells and 10 new aquifer tube locations beyond the existing 200-PO-1 Groundwater OU routine annual groundwater-monitoring program.
I	B	Monitoring as detailed in Appendix B, Monitoring SAP
I	C	Assess the type of fate and transport models including initial sensitivity analyses for evaluating the remedial alternatives. This will be done in concert with groundwater modeling experts. See Section 5.4 for more information relate to modeling.
I	D	Identify, compile, and summarize existing geologic information in the 200 East and 600 Areas, including recent Waste Treatment Plant (i.e., vitrification plant) borehole investigations and Integrated Disposal Facility studies.
I	E	Compile and summarize the inventory data available (e.g., *Hanford Soil Inventory Model, Rev. 1* [CHG 2005]) for the waste sites that may contribute to the VZ above the 200-PO-1 Groundwater OU
I	F	Determine the geophysical methods to be used per Appendix A, Characterization SAP, Sections A1.5 and A3.9. Establish appropriate contracts for these surveys. Perform the surveys.

Table 5-1. Overview of the Phases and Tasks for the Generation of the Remedial Investigation/Feasibility Study for 200-PO-1 Groundwater Operable Unit. (2 Pages)

Phase	Task	Description of Work
I	G	Use the information in tasks C, D, E, and F and Table 4-7 (geophysical, geochemical, and sediment properties) of this Work Plan to determine any added characterization information needed for modeling.
II	A	Compile and summarize investigation information from Phase I to support additional remedy decision data needs evaluation.
II	B	Determine the well locations for Phase II and determine the information/characterization needed from these wells.
II	C	Obtain the data from the new wells
II & beginning of the RI	D	Continue additional investigations as needs are identified. Analyze and summarize available data.
End of Phase I and Phase II		Perform the fate and transport modeling including the sensitivity analysis needed for the FS as discussed below.
RI	Baseline risk assessment	Summarize available data and perform the baseline risk assessment
FS		Establish remedial alternatives and perform the alternative screening process
RI/FS		Produce the RI as discussed below and generate the FS as discussed in Chapter 6.0 of this Work Plan.

OU = operable unit.
RI/FS = remedial investigation/feasibility study.
SAP = sampling and analysis plan.

5.3 FIELD INVESTIGATION AND CHARACTERIZATION

RL prepared a Characterization SAP for collecting additional remedial investigation data in the 200-PO-1 Groundwater OU as previously described in Section 4.1.2 of this Work Plan (Appendix A). The additional COPC concentration, geochemical, hydraulic, and geophysical data are intended to fill data gaps identified during the DQO for adequately characterizing the distribution and migration pathways for existing and potential groundwater contaminants, and modeling the unconfined and confined aquifers. The data are also useful for human-health risk screening and the evaluation of remedial alternatives. The planned data acquisition efforts are described in Section 4.3.1 and Appendix A of this Work Plan.

The Characterization SAP will complement data that are already collected during routine annual and quarterly groundwater monitoring as previously presented in Section 4.1.1 of this Work Plan. Routine monitoring is described in the Monitoring SAP.

5.4 GROUNDWATER MODELING APPROACH

A modeling system that is capable of predicting the movement of contaminants through the VZ to groundwater, and subsequently to the Columbia River, is required to calculate cleanup levels, identify preferential pathways, predict contaminant migration rates and pathways, and evaluate remedial alternatives. As a potential input to the model, any source term information provided by the waste sites and migration into the VZ will be considered in the modeling. As mentioned in Section 4.5, a specific groundwater model is not yet selected for the 200-PO-1 Groundwater OU. Depth-discrete and other data that are acquired during implementation of the Characterization SAP are expected to include modeling parameters. The *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (EIS) (FR 5655-5660 76 FR 5655, "Notice to Prepare the Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington") is being prepared to address waste facility and tank closure operations that overly the 200 Areas. This EIS (FR 5655-5660) involves extensive modeling on a large scale, using large grid sizes. The EIS is not completed; therefore, the details of the model are not yet published. An assumption is that the model used in the EIS will be used across the Hanford Site, in accordance with Table 1-1 of DQO Assumption #3 (FH 2007a).

A simplified model with a smaller grid size may be required to evaluate remedial alternatives for contamination portion of 200-PO-1 Groundwater OU.

Phase I will include evaluating simplified models and the EIS model. A decision is planned to be made in Phase I regarding the type of model needed and the applicable inputs. Updated vertical profiles of selected parameters will be developed from depth-discrete data such as recent seismic drilling to support the Waste Treatment Plant and modeling data packages from previous work performed at the Hanford Site (*Groundwater Data Package for Hanford Assessments* [PNNL 2006]). Input values for required modeling parameters will be obtained from actual field data, or from literature estimates. Where plausible, real data will be used in the model so that uncertainty in the output will be minimized.

5.5 REMEDIAL INVESTIGATION REPORT

Chapter 3.0 provides a summary of the previous investigations that have been performed to characterize various aspects or to address specific concerns of the 200-PO-1 Groundwater OU. The RI report will provide a summary of site investigations conducted within the 200-PO-1 Groundwater OU. The RI report will include analyses of ongoing activities, data collection performed as part of interim measures, and data generated as a result of the activities described in this Work Plan. The generated data from Phase I (see Section 4.3.2 for more information on the phased approach) will include results from groundwater sample analyses and groundwater modeling output for the 200-PO-1 Groundwater OU. The RI report will summarize Phase I and Phase II data that are the basis for conclusions regarding the nature and extent of contamination within the 200-PO-1 Groundwater OU, the potential for future groundwater contamination, and contaminant migration pathways. The RI report will identify remaining data gaps and will provide information necessary to conduct a risk assessment for the

200-PO-1 Groundwater OU. The RI report will include a baseline risk assessment. Additional descriptions of the baseline risk assessment are presented in Section 6.1 of this document.

5.6 CONCEPTUAL SITE MODEL

A conceptual model for the hydrogeology of the 200-PO-1 Groundwater OU is described in the *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington* (PNNL 2000a). The PNNL study concluded that two aquifers exist within the suprabasalt sediments of the 200 East Area. The upper Hanford unconfined aquifer occurs in the sediments of unit 1 of the Hanford formation and unit 5 (i.e., unit E) of the Ringold Formation (see Figure 5-1). As shown in Figure 2-1, groundwater in the unconfined aquifer generally flows southeast and east toward the Columbia River.

An underlying confined aquifer was identified where unit 9 (units 9A, 9B, 9C) is separated from the unconfined aquifer by the unit 8 aquiclude (see Figure 5-1). The resulting fluvial sand and gravel aquifer is referred to as the Ringold Formation confined aquifer. Groundwater flow in the Ringold Formation confined aquifer appears to converge from the west, south and east in the 200 East Area according to PNNL 2007. It is postulated that groundwater was forced into the Ringold Formation confined aquifer from the Hanford unconfined aquifer under the B Pond when mounding occurred during effluent disposal.

PNNL also described a deeper confined aquifer in the Columbia River Basalt Group underlying the Ringold Formation. The upper basalt-confined aquifer occurs within fractured basalt and interbeds of the Upper Saddle Mountains Basalt that directly underlies the Ringold Formation confined aquifer. Groundwater generally flows from west to east within the upper basalt-confined aquifer. Vertical gradients are upward at most 200-PO-1 Groundwater OU locations.

The 200-PO-1 Groundwater OU hydrogeology is further described in the Monitoring SAP (DOE/RL 2005a). The Monitoring SAP briefly describes the same three aquifers that are detailed in PNNL 2000a. A prominent feature of the 200 East Area is described in both the Monitoring SAP and PNNL 2000a. A large paleo-flood channel complex filled with Hanford sediments trends NW-SE across the 200 East Area. The paleo-flood channel complex cuts through the Ringold lower mud unit in the 200-PO-1 Groundwater OU, resulting in direct contact of the Hanford and lower Ringold sand and gravel sediments. The upper unconfined aquifer merges with the lower semi-confined aquifer in the vicinity of the paleo-flood channel complex. A computer-enhanced paleo-flood channel complex map is shown in Figure 5-2.

Another prominent structural feature in the 200-PO-1 Groundwater OU is the May Junction Fault that is located east of B Pond and the TEDF. The fault might provide a vertical preferential flow path for groundwater to move from the Ringold confined aquifer into the Hanford unconfined aquifer (Section 4.2.3, PNNL 2000a).

Figure 5-1. A Conceptual Model of the Lithological Units and Artificial Groundwater Recharge at B Pond and Treated Effluent Disposal Facility.

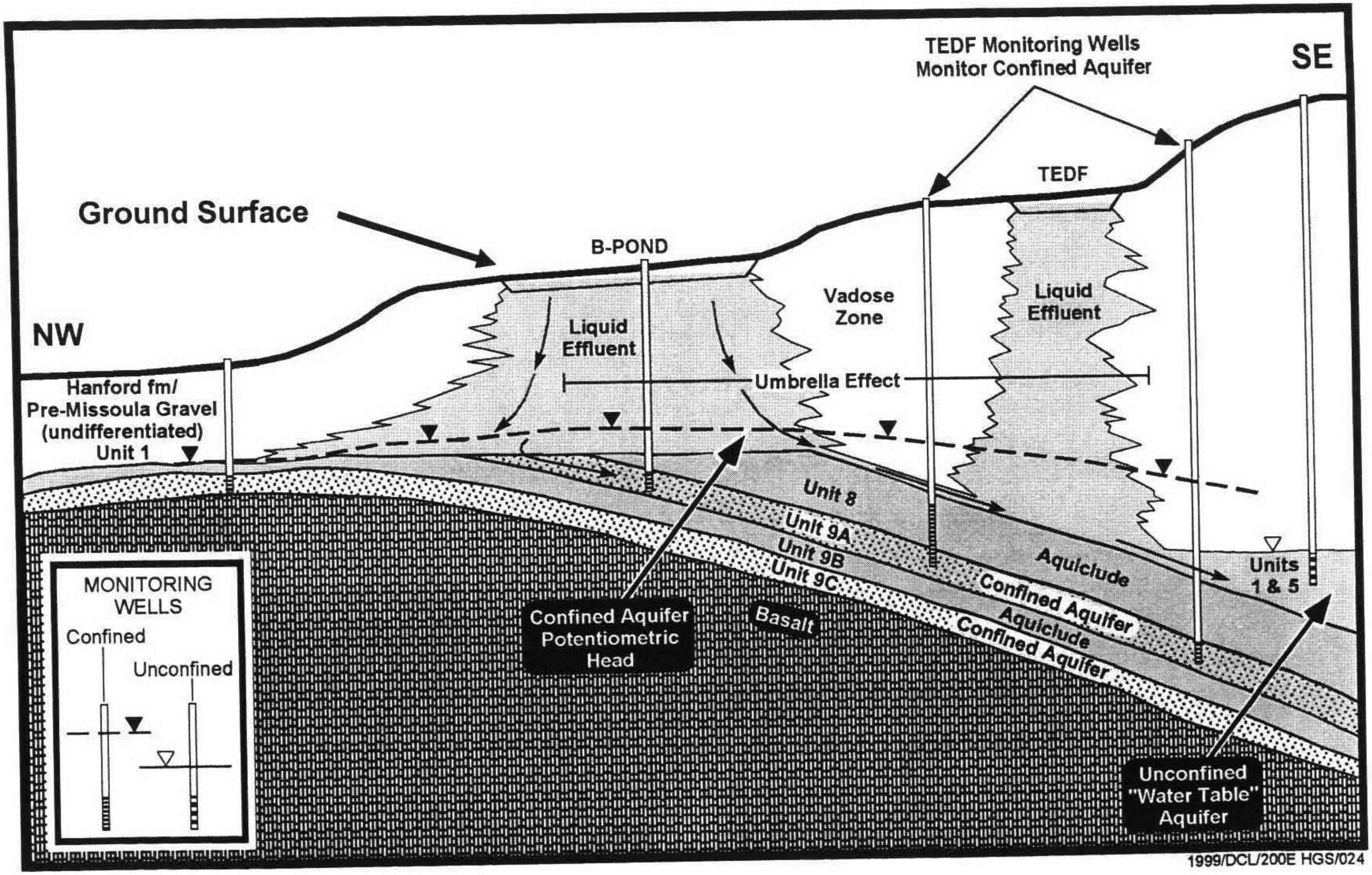


Figure 5-2. Computer-Enhanced Paleo-flood Channels of the Hanford Site.

Artificial groundwater recharge from effluent disposal at B Pond, PUREX, and other waste sites generated local mounds in the water table and generally elevated the water table throughout the 200 East Area. The groundwater mound under the B Pond caused an estimated additional 10 m (35 ft) of hydraulic head. The resulting downward gradient and radial flow pattern reversed groundwater flow in the 200 East Area to a western direction away from the Columbia River. The B Pond is located where the Hanford unconfined aquifer and the Ringold confined aquifer are connected. The downward gradient that was generated during disposal operations could have forced contaminants into the Ringold confined aquifer. Alternatively, the relatively impermeable Ringold lower mud unit (unit 8) could have diverted groundwater flow and contaminants laterally down the east and southeast through an umbrella effect (Section 4.2.1, PNNL 2000a). The lithological units and the artificial recharge at the B Pond and TEDF are illustrated in Figure 5-1. Effluent disposal and the associated artificial groundwater recharge at the B Pond ceased in 1997.

Sufficient effluent volumes were disposed of at PUREX and other waste sites to result in additional artificial groundwater recharge. The effluent volumes disposed of at PUREX were lower than at the B Pond, but the associated contaminants were generally more concentrated. A conceptual model for the migration of contaminants from the PUREX cribs to groundwater is shown in Figure 5-3. Enhancements to the conceptual models for the 200-PO-1 Groundwater OU waste sites are expected as additional geophysical and other data are collected.

The Monitoring SAP lists waste sites grouped around three major facilities as the primary contributors to groundwater contamination in the 200-PO-1 Groundwater OU: PUREX, B Plant, and the BC Cribs and Trenches Area where U Plant waste was disposed. The PUREX Plant and the BC Cribs and Trenches Area are located in the 200-PO-1 Groundwater OU. The B Plant is located in the 200-BP-5 Groundwater OU on the northern boundary of 200-PO-1 Groundwater OU. Six RCRA TSD units are located in the near-field area of 200-PO-1 Groundwater OU: the PUREX Cribs, Waste Management Area A-AX, the 216-A-29 Ditch, 216-B-3 Pond (B Pond), the Integrated Disposal Facility (a RCRA-compliant landfill that is scheduled to begin receiving waste in FY 2010), and the NRDWL. Three additional waste sites in the 200-PO-1 Groundwater OU that are regulated by the *Washington Administrative Code* are the 200 Areas TEDF, Solid Waste Landfill, and 400 Area process ponds.

Tritium, nitrate, and I-129 are identified in the Monitoring SAP and the Annual Monitoring Report (PNNL 2007) as major groundwater COPC plumes that generally coincide and extend outside the 200 East Area. As discussed in Section 4.2.2, tritium, nitrate, and I-129 are the groundwater contaminants for the far-field area and are also present in the near-field area. The tritium groundwater plume is described in the Annual Monitoring Report as primarily associated with the PUREX cribs, and generally attenuating through radioactive decay and dispersion. The tritium plumes in 1980 and 2006 within the unconfined aquifer are illustrated in Figure 5-4. Figure 5-5 presents 2006 tritium concentrations across the Hanford Site.

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Figure 5-3. Conceptual Site Model for the PUREX Cribs and BC Cribs and Trenches Area. (WMA-C single-shell tanks and LLWMA-2 are not included in the 200-PO-1 Groundwater Operable Unit.)

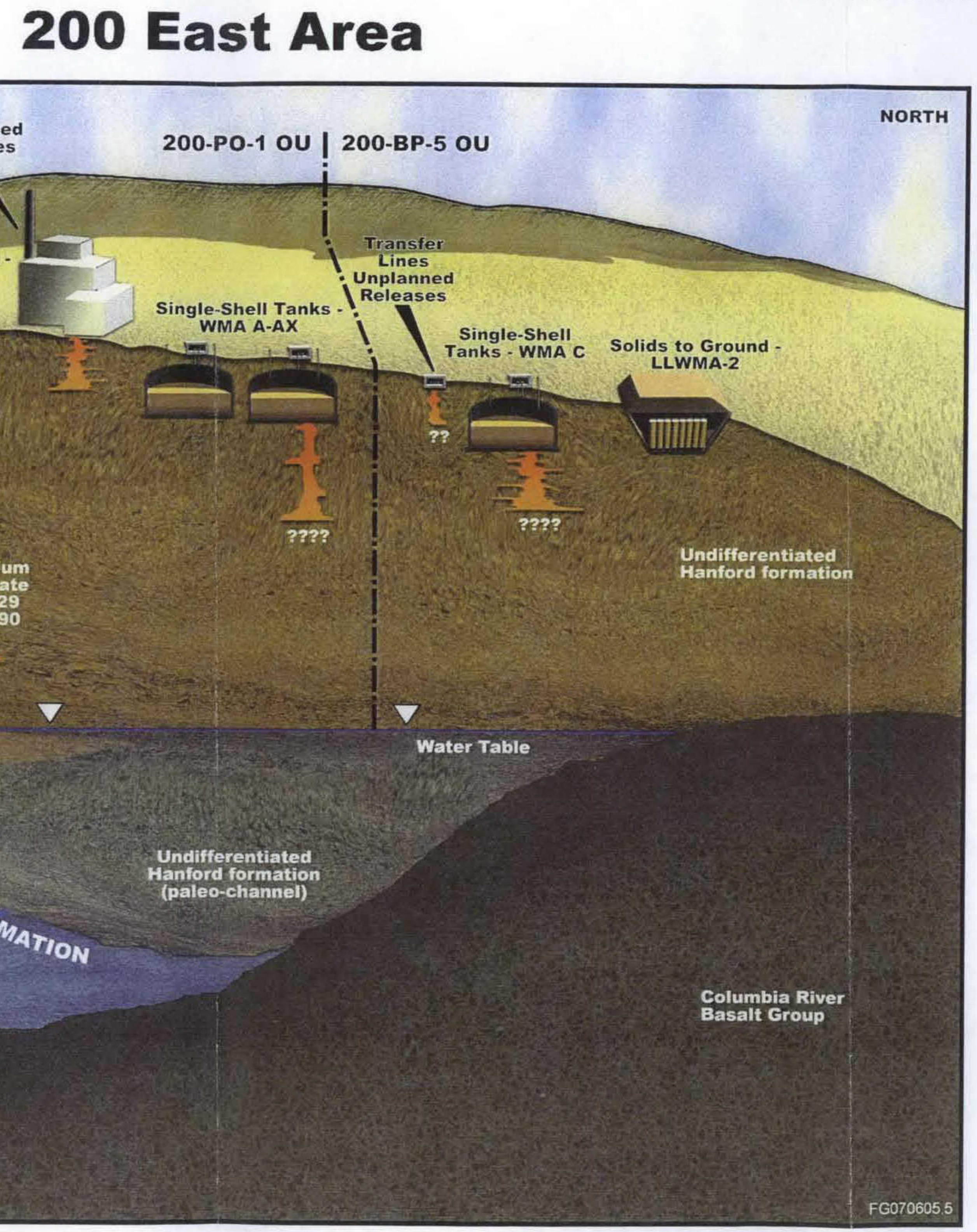


Figure 5-4. Tritium Groundwater Plume in the 200-PO-1 Groundwater Operable Unit in 1980 and 2006.

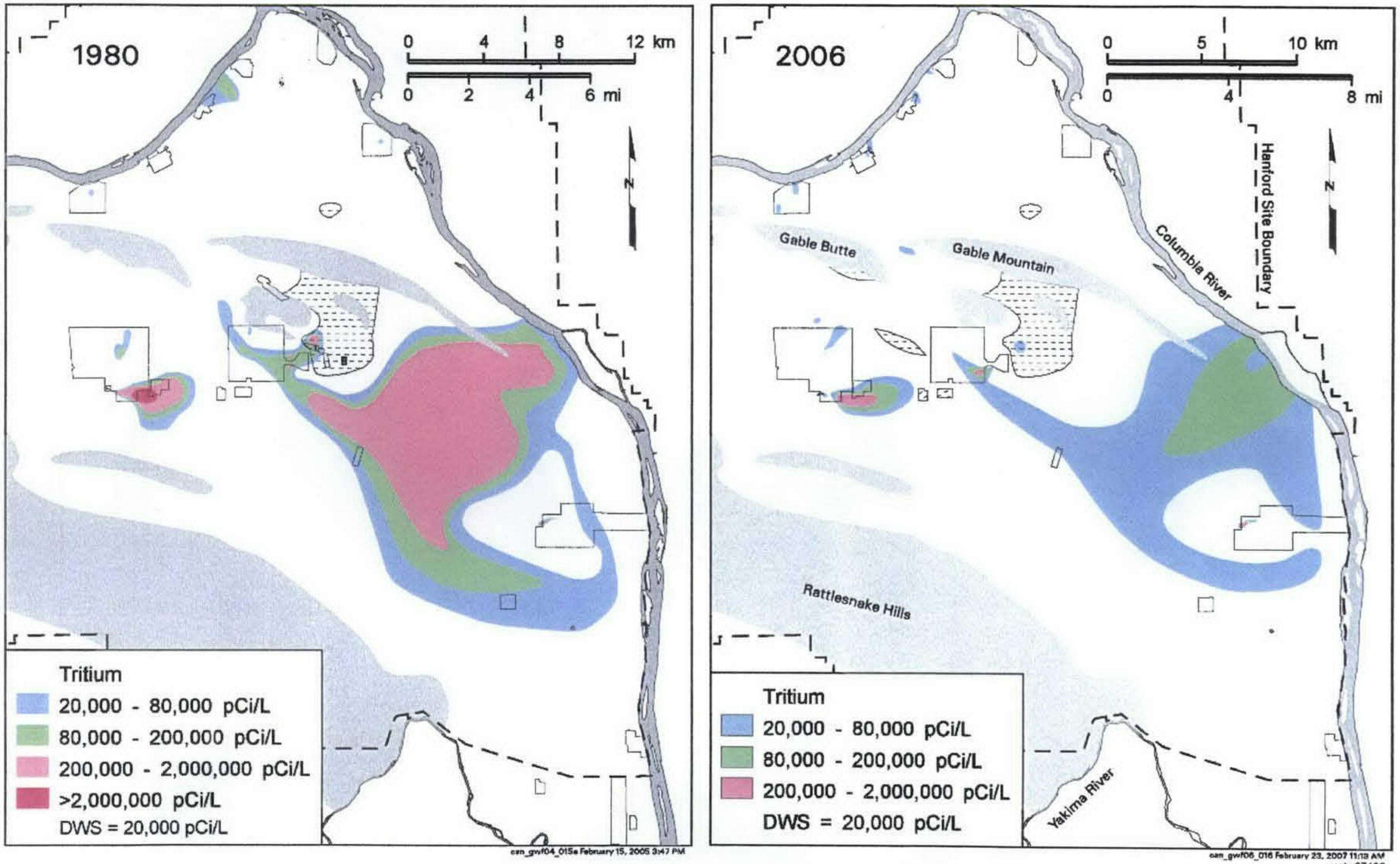
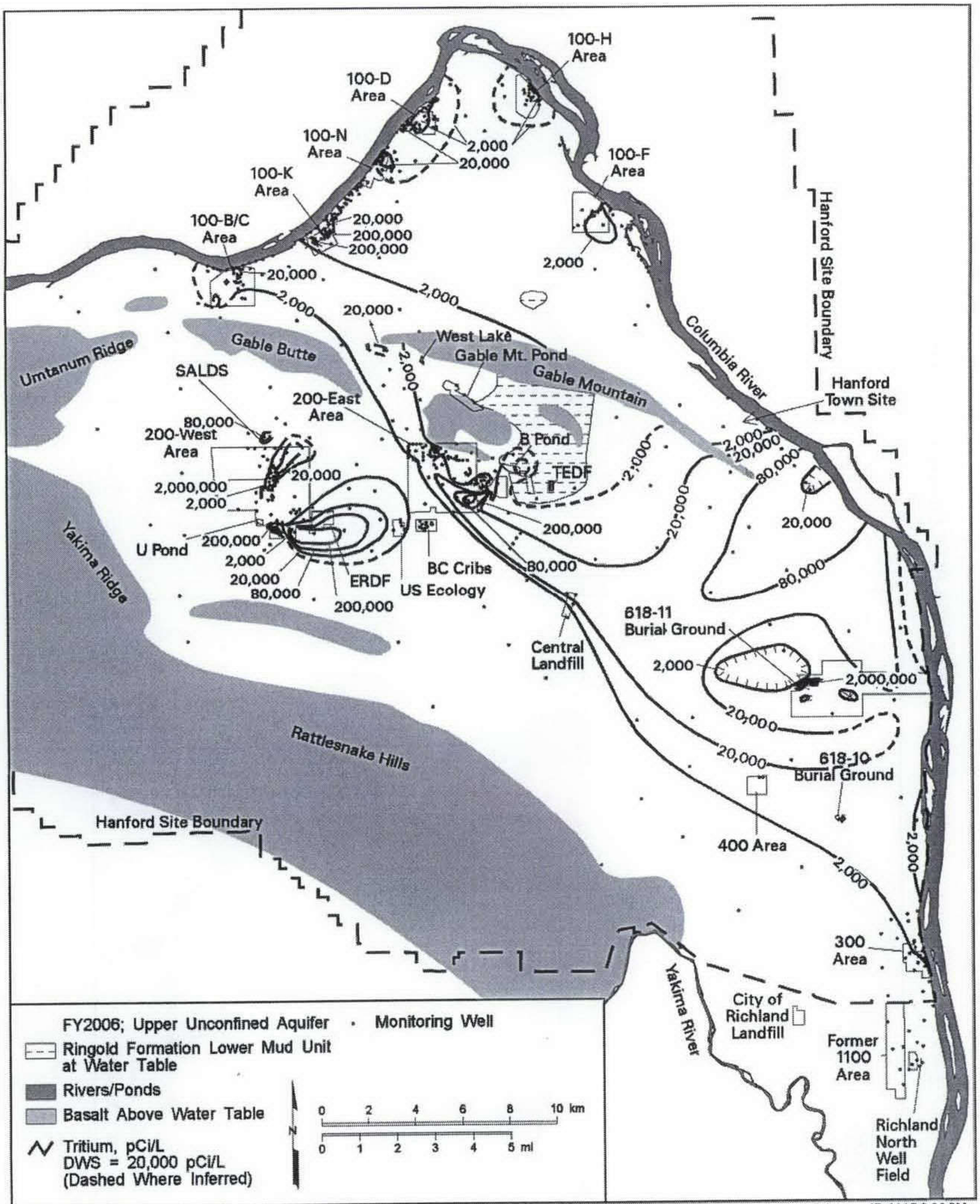


Figure 5-5. 2006 Hanford Site Tritium Groundwater Plume.



Nitrate concentrations have exceeded the drinking water standard of 45 mg/L, or 10 mg/L as nitrogen in nitrate near PUREX Cribs, WMA A-AX, and the 400 Area. The Annual Monitoring Report (PNNL 2007) states that the nitrate plume appears to be receding except in three areas: the southern portion near the 300 Area, PUREX cribs, and Waste Management Area A-AX. The nitrate plumes in 1980, 2004, and 2006 are shown in Figures 5-6, 5-7, and 5-8 respectively.

An I-129 groundwater plume extends southeast from the 200 East Area into the 600 Area. The Annual Monitoring Report describes the PUREX cribs as the sources for the I-129 plume. The highest I-129 groundwater concentration in the 200-PO-1 Groundwater OU occurred near the PUREX cribs during FY 2006. An I-129 activity level of 9.1 pCi/L was found in well 299-E17-14 near the 216-A-36B Crib. The I-129 plumes in 1994, 2004, and 2006 are shown in Figures 5-9, 5-10, and 5-11 respectively.

The Annual Monitoring Report describes three far-field (i.e., tritium, nitrate, and I-129) and nine near-field groundwater contaminants (i.e., Sr-90, Tc-99, arsenic, chromium, manganese, vanadium, Co-60, cyanide, and uranium). The following groundwater contaminant information is available in the Annual Monitoring Report for FY 2006 results.

- Iodine-129 was not detected during FY 2006 in the few wells that are completed in the deep unconfined aquifer or the confined aquifers (Section 2.11.1.2, PNNL 2007).
- Tritium was detected in only one deep well (a water supply well in the 400 Area that is screened in the unconfined aquifer). Tritium was not detected in the basalt-confined aquifer (Section 2.11.1.1, PNNL 2007).
- A localized area of Sr-90 groundwater contamination occurs near the 216-A-36B Crib. The low mobility of Sr-90 in groundwater is considered the primary factor for limiting its extent (refer to Figure 5-12).
- Technetium-99 groundwater contamination is associated with Waste Management Area A-AX and indirectly, through gross beta measurements, with the PUREX cribs (refer to Figures 5-13).
- Arsenic and manganese were identified in groundwater samples from wells near the PUREX cribs during FY 2006. The current manganese concentrations are less than the 50 μg/L secondary drinking water standard. Both the Monitoring SAP and the Annual Monitoring Report mention that manganese concentrations detected near the PUREX cribs could result from corrosion of carbon-steel casing in older monitoring wells.
- Chromium, Cobalt-60, cyanide, and uranium are COPCs at the BC Cribs and Trenches Area. The groundwater contaminant that was detected above background levels in the BC Cribs and Trenches Area in FY 2006 was chromium in well 299-E13-14. A chromium plume is migrating into the BC Cribs and Trenches Area from the west and southwest, and might be impacting wells where chromium was detected.

The highest vanadium concentrations in the 200-PO-1 Groundwater OU were found at PUREX cribs, the 216-A-29 Ditch, and the B Pond. There is no drinking-water standard for vanadium.

Figure 5-6. Nitrate Groundwater Plume in the 200-PO-1 Groundwater Operable Unit in 1980.

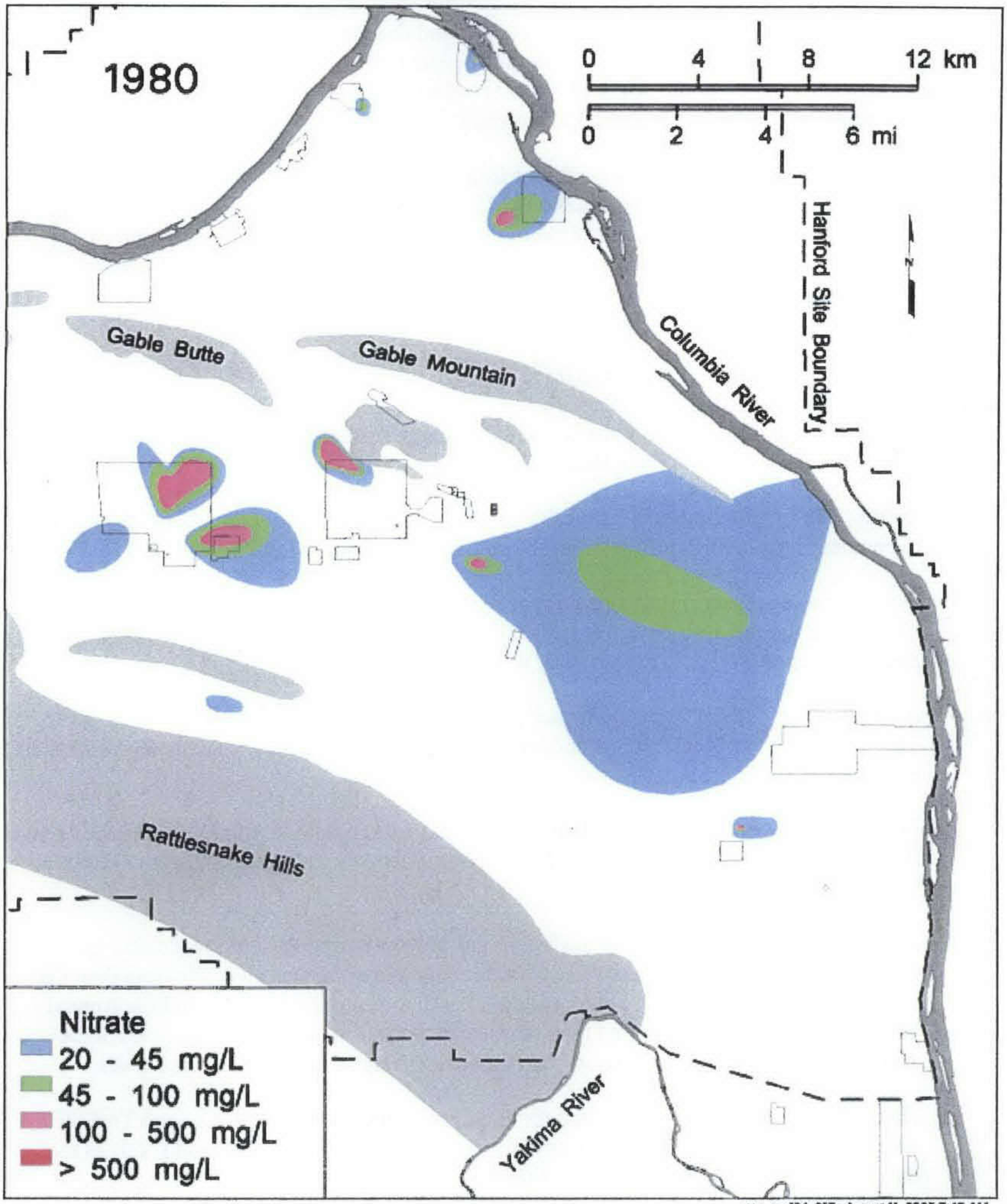


Figure 5-7. Nitrate Groundwater Plume in the 200-PO-1 Groundwater Operable Unit in 2004.

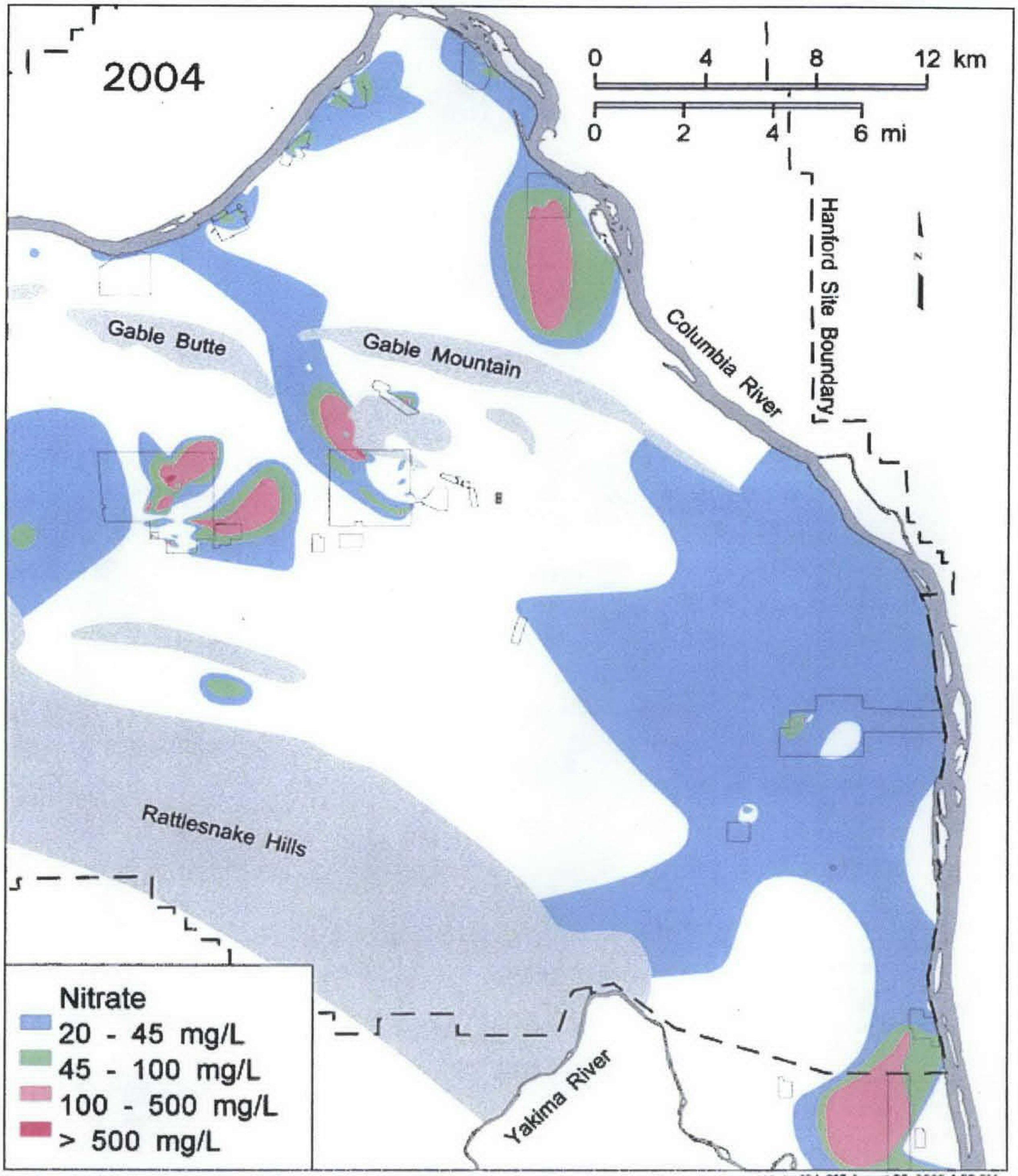


Figure 5-8. 2006 Hanford Site Nitrate Groundwater Plume.

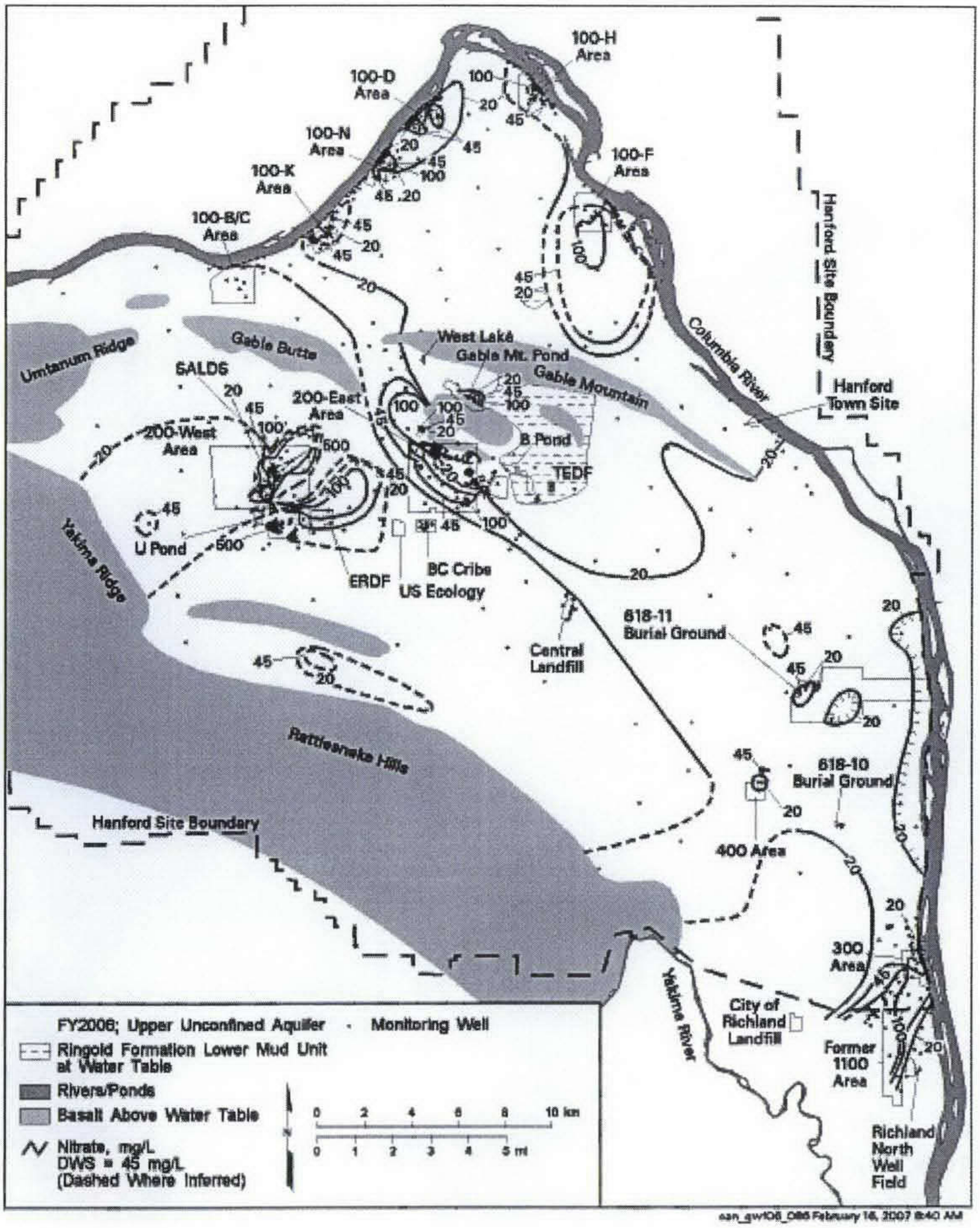


Figure 5-9. Iodine-129 Groundwater Plume in the 200-PO-1 Groundwater Operable Unit in 1994.

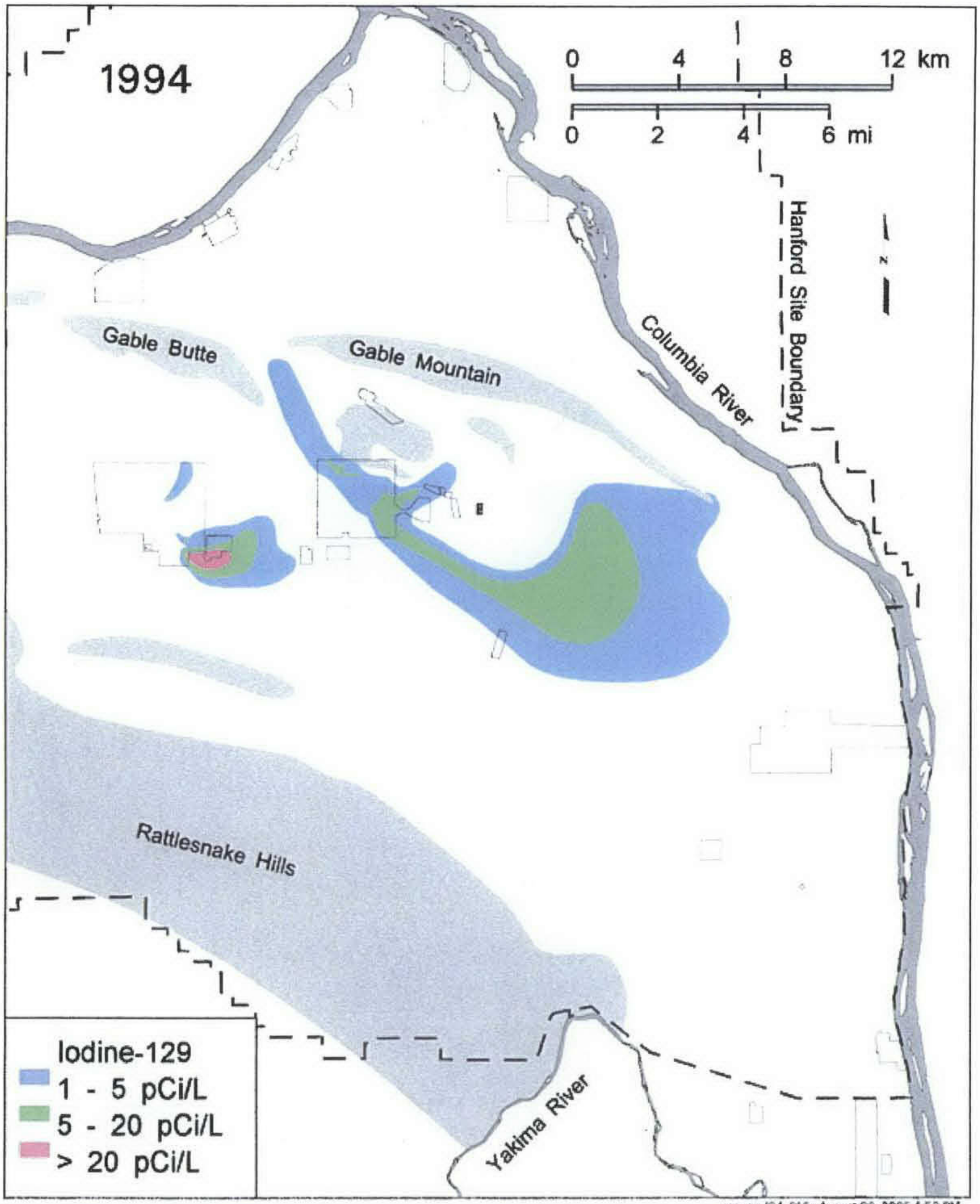


Figure 5-10. Iodine-129 Groundwater Plume in the 200-PO-1 Groundwater Operable Unit in 2004.

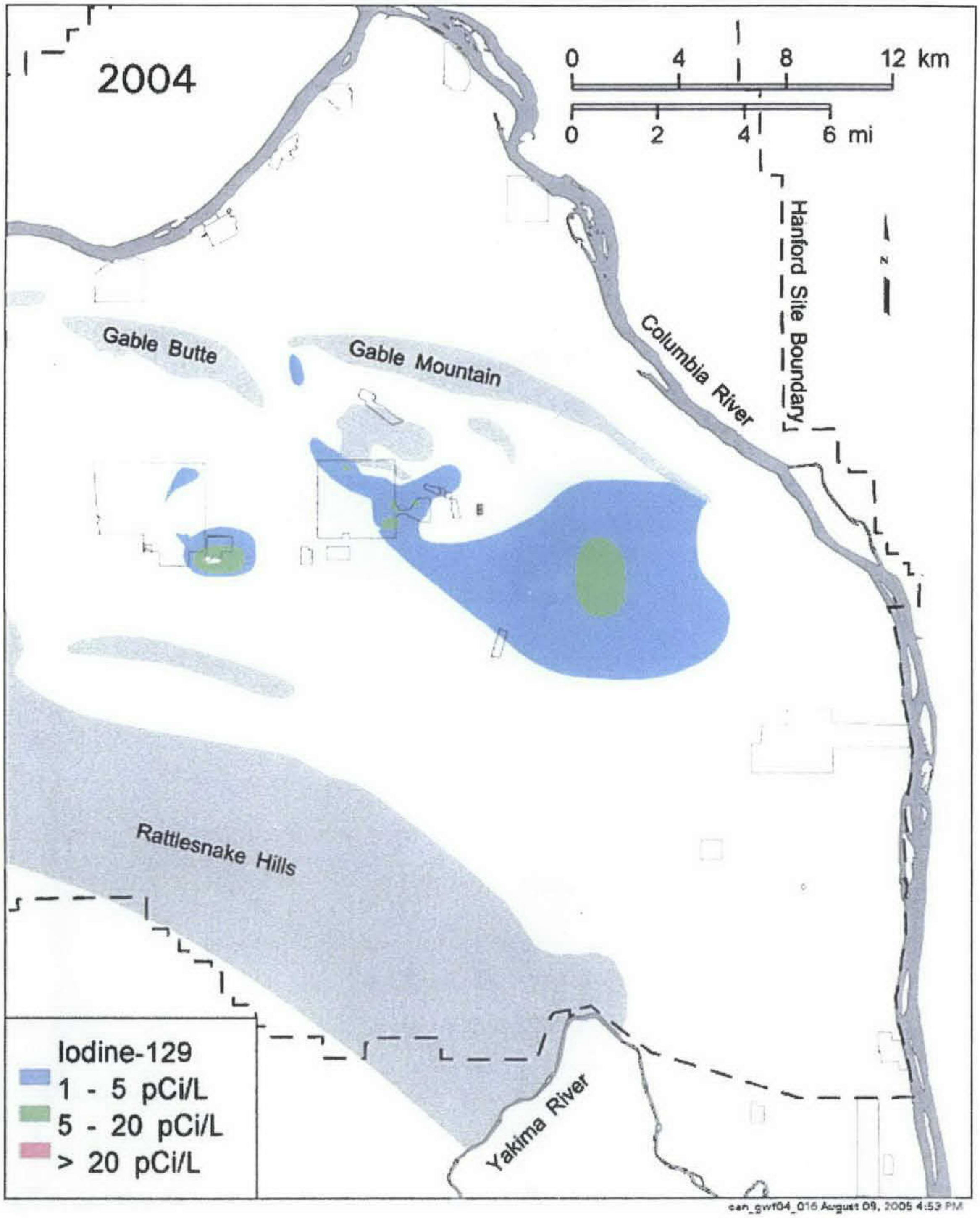


Figure 5-11. Iodine-129 Groundwater Plume in the 200-PO-1 Groundwater Operable Unit Near-Field Area in 2006.

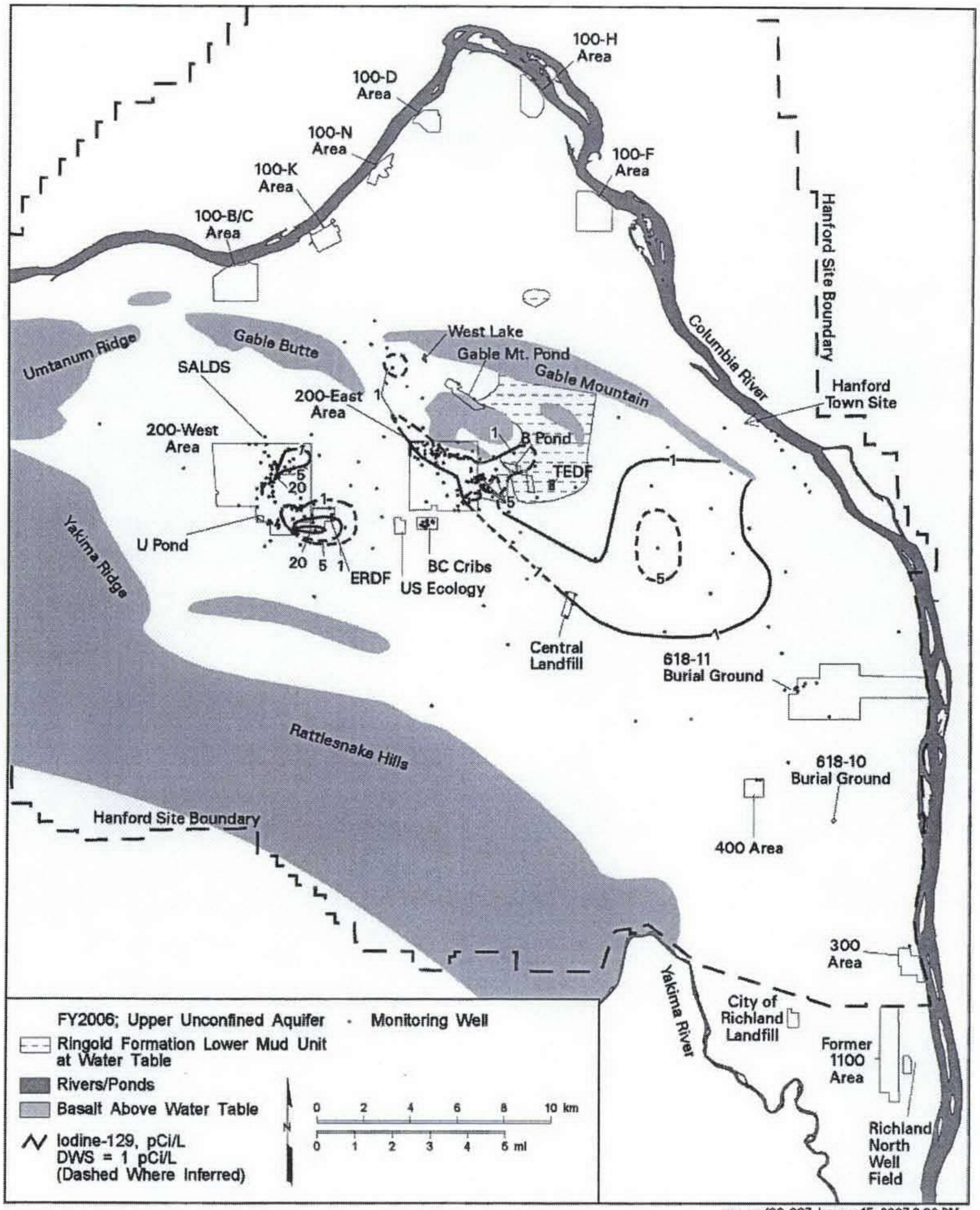


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Figure 5-12. Strontium-90 Groundwater Plume in 200-PO-1 Groundwater Operable Unit Near-Field Area in 2006.

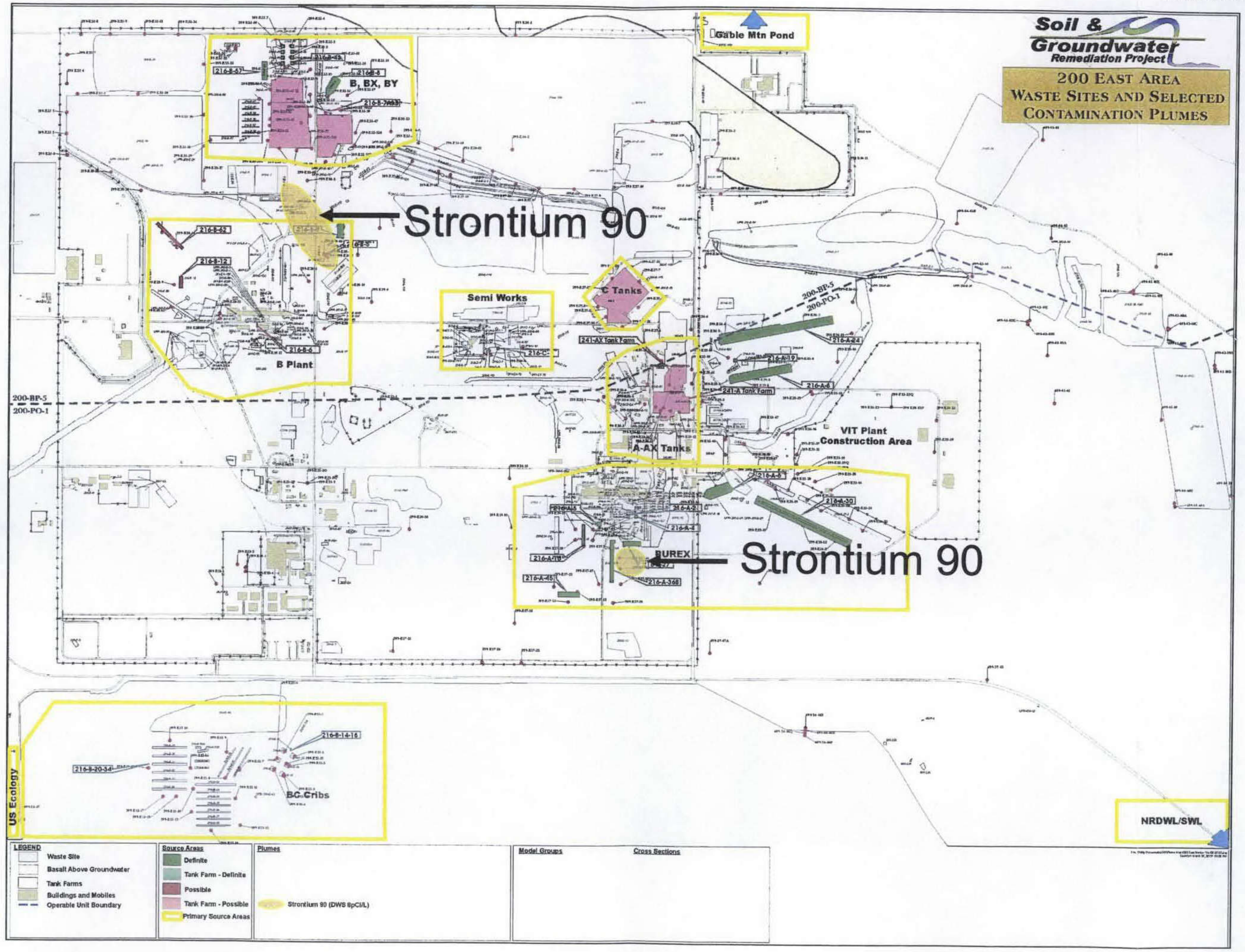
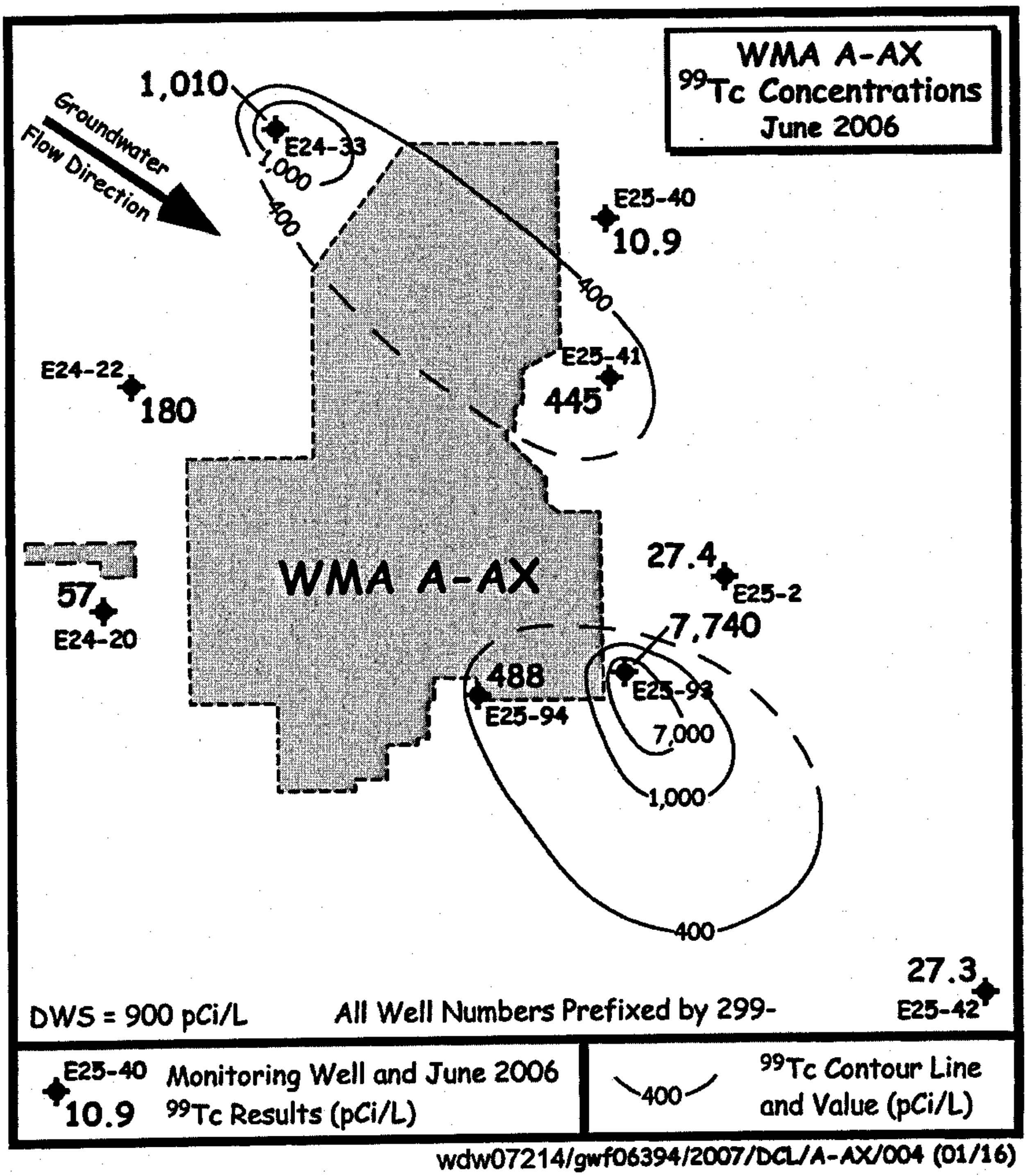


Figure 5-13. Technetium-99 Groundwater Plume at WMA-A-AX in 2006.



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6.0 FEASIBILITY STUDY

A baseline risk assessment will be presented as part of the RI. The base-line risk assessment and the applicable or relevant and appropriate requirements (ARAR) are used to develop general remedial action objectives. The remedial action objectives will be used to execute the FS in three phases: (1) the development of alternatives, (2) the screening of alternatives, and (3) the detailed analysis of alternatives. The FS will include the risk assessment associated with each remedial alternative evaluated. The FS will recommend one or more remedial alternatives.

Ecological risk also will be considered during the RI/FS. Existing information and analysis for the exposure pathways from groundwater to terrestrial ecological receptors in the 200 Areas Central Plateau are incomplete. The ecological risk to receptors in the Columbia River environment (riparian zone and river) will be evaluated. Section 6.1.2 provides added detail on the Ecological Risk Assessment.

Categories of remedial alternatives will be developed that may include, but are not limited to, the following:

- No action
- Institutional controls
- Monitoring natural attenuation
- Pump-and-treat (*ex-situ* treatment)
- Permeable or impermeable containment (*in-situ* treatment)

These actions may be taken singly or in combination (e.g., pumping and ex situ treatment of groundwater) to satisfy the remedial action objectives for the 200-PO-1 Groundwater OU.

Groundwater volumes or areas will be identified to which general response actions could be applied. The FS will identify and screen technologies to eliminate those that cannot be technically implemented at the site.

Technology process options will be identified and evaluated in order to select a representative process for each technology type that is retained for consideration. The first phase of the FS will be completed by assembling the selected representative technologies into alternatives representing a range of treatment and containment combinations, as appropriate.

The FS will document detailed analysis of remedial alternatives. The evaluation criteria include two threshold criteria, five balancing criteria, and two modifying criteria for a total of nine criteria.

The two threshold and five balancing criteria listed below are discussed in the FS:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence

- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost.

After the previous seven criteria are applied, and after comments on the FS are received from the public, two modifying criteria listed below will be applied:

- State acceptance
- Community acceptance.

6.1 RISK ASSESSMENT

6.1.1 Human-Health Risk Assessment

For the 200-PO-1 Groundwater OU, a quantitative baseline human-health risk assessment will be prepared as part of the RI report. The risk assessment will evaluate risk to human receptors from potential exposure to contaminants in areas where groundwater is accessible or reaches the Columbia River.

The risk assessment serves two purposes in the CERCLA process. The first purpose is to establish a baseline risk. The purpose of the baseline risk assessment is to:

- Define the COPCs,
- Identify exposure pathways,
- Estimate the risk associated with taking no-action, and
- Establish the need to take action.

The second purpose is to establish remedial action objectives. The establishment of the remedial action objectives serves to the following purposes.

- Establish cleanup levels when no ARARs exist.
- Determine "protectiveness" to the human health and the environment threshold.
- Evaluate risk reduction compared to the baseline conditions.
- In conjunction with ARARs and other considerations, help to establish Points of Compliance.

Given that known plumes exist that exceed the MCLs used for drinking water; an FS will evaluate a potential remedy.

The baseline risk assessment is planned to be done after the *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, is presented. The EIS will cover risk evaluations for all of the tank farms including 241-AZ, 241-AX, 241-AY, 241-A, 241-AW, 241-AP farms. The goal is to be consistent with the risk assessment from the EIS and the risk assessment that is done as part of this RI/FS. Based on current schedules, it is likely that the baseline risk assessment and the evaluation of the risk reduction evaluation will both be performed as part of the FS.

The following guidance documents will be used, as appropriate, to develop the risk assessment:

- Federal EPA
  - EPA 1989, *Risk Assessment Guidance for Superfund (RAGS), Volume I – Human Health Evaluation Manual, (Part A) Interim Final,* OSWER 9285.7-01A (EPA 540/1-89/002)
  - EPA 1991, *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final)*, OSWER Directive 9285.6-03
  - EPA 1992, *Guidance for Data Useability in Risk Assessment*, Part A (Publication 9285.7-09A) and Part B (Publication 9285.7-09B)
  - EPA 1997, *Exposure Factors Handbook*, Volumes I–III (Update to Exposure Factors Handbook EPA/600/8-89/043, May 1989), EPA/600/P-95-002Fa, August
  - EPA 2002a, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*, OSWER 9285.6-10
  - EPA 2002b, *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, OSWER 9355.4-24
  - EPA 2004, *Final Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manua*l (Part E, Supplemental Guidance for Dermal Risk Assessment).
- Federal DOE
  - EH 1992a, *CERCLA Baseline Risk Assessment and Human Health Evaluatio*n (EH-231-012/0692)
  - DOE/EH 1995, *CERCLA Baseline Risk Assessment Reference Manual for Toxicity and Exposure Assessment and Risk Characterization* (DOE/EH 0484)
  - DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*
  - EH 1992b, *Use of Institutional Controls in a CERCLA Baseline Risk Assessment* (EH-231-014/1292).
  - DOE O 450.1, *Environmental Protection Program*
  - DOE O 435.1, *Radioactive Waste Management*

- State of Washington – *Washington Administrative Code*
  - Groundwater cleanup levels – WAC 173-340-720, "Ground Water Cleanup Standards"
  - Soil cleanup levels – WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," and WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."
- Hanford Site-specific
  - *Hanford Site Risk Assessment Methodology* (DOE/RL 1995).
- HAB Advice #132 ("Exposure Scenarios Task Force on the 200 Area" [HAB 2002]).

6.1.2 Ecological Risk Assessment

The screening-level ecological risk assessment in *Ecological Evaluation of the Hanford 200 Areas – Phase 1: Compilation of Existing 200 Areas Ecological Data* (DOE/RL 2001b) is meant to be a conservative evaluation of risk to ecological receptors from stressors, in this case, introduction of contaminants and habitat elimination. The screening-level ecological risk assessment identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures.

A Central Plateau ecological risk assessment document is currently in preparation. In addition, the River Corridor Project and the Inter-areas are generating ecological risk assessments. The 200-PO-1 Groundwater OU ecological risk assessment will be consistent with both of these forthcoming documents. The screening-level ecological risk assessment in DOE/RL 2001b is meant to be a conservative evaluation of risk to ecological receptors from stressors, in this case, introduction of contaminants and habitat elimination. The screening-level ecological risk assessment identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures. The risk-screening document will be an input document to the risk assessments that are underway or planned. The ecological risk assessment for the 200-PO-1 Groundwater OU must consider two areas, the Central Plateau/Core Zone and the area along the Columbia River. Because no groundwater reaches the surface in the Central Plateau/Core Zone, no ecological risk assessment is planned for this area.

This is consistent with ecological risk at other groundwater OUs (e.g., 200-ZP-1) where the groundwater does not reach the surface. Because groundwater may enter the Columbia River along the shore, it is appropriate to consider risk contribution from 200-PO-1 Groundwater OU along the Columbia River. In addition the River Corridor Project and the Inter-areas are generating ecological risk assessments. Ecological risk assessment is also underway for the 200-ZP-1 Groundwater OU. The Core Zone and Central Plateau area of 200-PO-1 Groundwater OU will be consistent with the approach used for the Core Zone and Central Plateau assumptions for 200-ZP-1. In the 200-ZP-1, contributions from the groundwater to riparian area along the river were calculated and provided to the River Corridor Project and the Inter-areas for inclusion in the River Corridor and Inter-areas risk assessment projects.

6.2 LAND USE

To identify appropriate cleanup objectives, the future land use of a site must be considered. Current and future land uses of the 200 Areas and the Central Plateau are discussed below.

6.2.1 Current Land Use

All current land-use activities associated with the 200 Areas and Central Plateau are industrial in nature. The DOE-selected land use for the 200 Areas, documented through the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP) (DOE 1999) is industrial for areas located within the industrial (exclusive) use boundary and conservation (mining) for sites located outside of the industrial (exclusive) use boundary as shown in Figure 1-5.

The conservation (mining) land use would enable the extraction of valuable near-surface geologic resources to support implementation of remedial actions (i.e., surface barriers) at some locations on the Hanford Site after obtaining *National Environmental Policy Act of 1969* (NEPA), RCRA, or CERCLA, approval to protect NEPA-sensitive resources (e.g., biologic, geologic, historic, or cultural). In addition, the HCP (DOE 1999) indicates that a notice of deed restriction would be placed in those areas where VZ contamination remained in place, according to a CERCLA ROD or RCRA closure permit, foreclosing the mining option. The Hanford Site has no metal ore reserves, therefore the term mining is not used in the traditional sense was not intended by the HCP. The HCP anticipates mining only for materials needed to build surface barriers as part of remedial actions and that mining would be precluded from contaminated areas. The conservation (mining) land use would afford protection of natural resources; however, other compatible uses (e.g., recreation or nonintrusive environmental research activities) would also be allowed, provided that these activities are consistent with the purpose of the conservation land-use designation. Conservation would require active management practices to enhance or maintain the existing resources and to minimize or eliminate undesirable or non-native species.

The HCP EIS ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement [HCP EIS]") identifies conservation (mining) as reserved for the management and protection of archeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes only) could occur as a special use (i.e., a permit would be required) within appropriate areas. Limited public access would be consistent with resource conservation. This ROD also indicates that mining would be restricted from contaminated areas.

According to the HCP (DOE 1999), industrial (exclusive) land use would preserve DOE control of the continuing remediation activities and would use the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and mixed-waste TSD facilities. The cleanup criteria for these sites must be consistent with either land use or PRGs, based on HAB Advice #132 (HAB 2002). This application of the core zone boundary is defined in the Tri-Parties response, or ("Consensus Advice #132: Exposure Scenarios Task Force of the 200 Area" [Klein et al., 2002]) to HAB Advice #132 (HAB 2002).

6.2.2 Anticipated Future Land Use

The reasonably anticipated future land use for the industrial (exclusive) use zone is continued industrial (exclusive) activities. Eventually, portions of this area may be used for non-DOE-related industrial uses. The DOE worked for several years with cooperating agencies and stakeholders, including the National Park Service, Tribal Nations, the states of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests, to define land-use goals and develop future land-use plans for the Hanford Site. The results were reported in *The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group* (HFSUWG 1992) and culminated in the HCP (DOE 1999) and associated ROD (64 FR 61615) issued in 1999.

The HCP was written to address the growing need for a comprehensive, long-term approach to planning and development on the Hanford Site because of DOE's separate missions of environmental restoration, waste management, and science and technology. The HCP analyzes the potential environmental impacts of alternative land-use plans for the Hanford Site and considers the land-use implication of ongoing and proposed activities. In the HCP, the land-use designation for sites inside the industrial (exclusive) area is as follows:

- Industrial (Exclusive core zone): areas suitable and desirable for TSD of hazardous, dangerous, radioactive, and nonradioactive wastes, and related activities.

For sites outside the industrial (exclusive) area, the land-use designation is as follows:

- Conservation (Area outside of core zone): an area reserved for the management and protection of archeological, cultural, ecological, and natural resources.

Under the preferred land-use alternative selected in the ROD (64 FR 61615), the area outside of the industrial (exclusive) area of the Central Plateau was designated for other activities. For the sites in the study area, the land use was designated as conservation (mining). This would include restrictions against intrusive human activities but would allow recreational use (e.g., hiking, biking, hunting, and bird watching where a receptor spends only a small fraction of time in actual proximity to the contaminated areas) of the surface areas. Restricted use (e.g., recreation or waste management) means that surface use of the waste sites could occur, but subsurface activities such as excavation, well drilling, and farming would be restricted to preclude contact with or disturbance of contaminated soils. These activities could occur *around* the waste sites, but not *on* the waste sites. Based on the risk framework workshops, groundwater use outside the core zone also would be restricted until remediation efforts result in meeting groundwater cleanup standards. At that point, unrestricted groundwater use would be assumed. The current and potential Land Use for the near field, far field, and river corridor regions are presented in Table 6-1.

The HCP indicates that contamination in the groundwater would restrict use (DOE 1999). Groundwater beneath the Central Plateau currently is contaminated and is not withdrawn for beneficial uses.

Operations at the Hanford Site are expected to terminate in approximately 2050, and active institutional controls are assumed for approximately another 100 years following the termination of operations. Effective passive institutional controls will be designed to endure to provide protection for at least 500 years, which is the time period stated for the Environmental Restoration Disposal Facility (ERDF) in the *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility* (EPA et al., 1995). Institutional controls are expected to be maintained until the contamination is no longer hazardous to human health or the environment.

Table 6-1. Current and Potential Future Land Use.*

Zone Boundary	Current Land Use	Potential Future Land Use
Near Field Inside Core Zone	Industrial (no use of groundwater).	Industrial Exclusive
Far Field Area Outside the Core Zone	Industrial (no groundwater use) for the next 150 years or other negotiated time.	Conservative (mining) reserved for management and protection of archeological, cultural, ecological, and natural resources.
River corridor	Industrial (no groundwater use) for the next 150 years	High and Low intensity Recreation, and Conservative (mining) reserved for management and protection of archeological, cultural, ecological, and natural resources. Must be consistent with the River Corridor land use risk assessment.

*"Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)," (64 FR 61615).

6.3 CONSIDERATION OF NEPA VALUES

NEPA values will be evaluated as part of DOE's responsibility. NEPA and its implementing regulations, the *National Environmental Policy Act Compliance Program* (DOE O 451.1B), *DOE Policies on Application of NEPA to CERCLA and RCRA Cleanup Actions* (DOE 2002a), and *Decommissioning Implementation Guide* (DOE G 430.1-4) require that NEPA values be incorporated into decisions and documents as part of the CERCLA process. These values include, but are not limited to, cumulative, ecological, cultural, historical, and socioeconomic impacts and Irreversible and Irretrievable statements in lieu of preparing separate NEPA documentation. The impacts of these aspects of the human environment usually are not otherwise addressed within the CERCLA process. This integration provides a more comprehensive analysis of potential impacts resulting from the proposed 200-PO-1 Groundwater OU cleanup activities. To support the CERCLA decision-making process NEPA value analysis will be addressed in the FS and resulting CERCLA decisions.

6.4 DEVELOPMENT OF REMEDIAL ALTERNATIVES

6.4.1 No Action

The National Contingency Plan (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan") requires that a no action alternative be evaluated as a baseline for comparison with other alternatives. The no action alternative represents a situation where no restrictions, controls, or active remedial measures are applied. No action implies a scenario of walking away from the site and taking no measures to monitor or control contamination. The no action alternative requires that a site pose no unacceptable threat to human health and the environment. Current information for the 200-PO-1 Groundwater OU indicates that some form of remedial action is required.

6.4.2 Institutional Controls

Institutional controls refer to physical and/or legal barriers to prevent access to identified contaminants, and are combined with some level of monitoring. Institutional controls are usually required when contamination is left in place above applicable cleanup levels.

Physical methods of controlling access to groundwater are controls such as signs, entry barriers, artificial or natural barriers, and active surveillance. Physical restrictions are effective in protecting human health by reducing the potential for contact with contaminated media and avoiding adverse environmental, worker safety, and community safety impacts that arise from the potential release of contaminants. Physical restrictions are not intended to contain, remove, or treat contaminants. Monitoring and maintenance are necessary to ensure long-term effectiveness of the selected physical restrictions.

Legal restrictions include administrative and real property covenants that prohibit groundwater use, thereby preventing future human exposure to remaining contaminants in an aquifer. Land-use restrictions and controls on real property development are effective in providing a degree of human-health protection by minimizing the potential for contact with contaminated media. Restrictions can be imposed through land covenants, which would be enforceable through lawsuits by the United States, under Washington State statutes, and/or the EPA. Restrictions also avoid adverse environmental, worker safety, and community safety issues that could arise from the potential release of contaminants associated with other remedial technologies (e.g., treatment). Land-use restrictions are typically more effective than access controls if site control is transferred from RL to another party.

The disadvantages of land-use restrictions are similar to those for access control in that they do not contain, remove, or treat contaminants. In addition, land-use restrictions are not self-enforcing. They can only be triggered by an effective system for monitoring land use to ensure compliance with the imposed restrictions.

6.4.3 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is not a technology, but rather describes a range of physical and biological processes which, unaided by deliberate human intervention, reduce the concentration, toxicity, or mobility of chemical or radioactive contaminants. These processes take place whether or not other active cleanup measures are in place.

The mechanisms of natural attenuation can be classified as destructive and nondestructive. Destructive processes include biodegradation and hydrolysis. Biodegradation is by far the most prevalent destructive mechanism. Biodegradation, also called bioremediation, is a process in which naturally occurring micro-organisms (e.g., yeast, fungi, and bacteria) break down target contaminants (e.g., fuels and chlorinated solvents) into less toxic or non-toxic substances. Like larger living things, these microbes must eat organic substances to survive. Certain micro-organisms digest fuels, chlorinated solvents, and other substances found in the subsurface environment. Nondestructive attenuation mechanisms include sorption, dispersion, dilution, and volatilization. Dilution, dispersion, and sorption are generally the most important nondestructive mechanisms.

Long-term monitoring is necessary to demonstrate that contaminant concentrations continue to decrease at a rate sufficient to ensure that they will not become a health threat or violate regulatory criteria. Monitoring should be designed to verify that potentially toxic transformation products are not created at levels that are a threat to human health; that the plume is not expanding; that there are not releases that could affect the remedy; and that there are no changes in hydrogeological, geochemical, or microbiological parameters that might reduce the effectiveness of natural attenuation.

The EPA provides guidance for use of MNA in the *Use of Monitored Natural Attenuation at Superfund RCRA Corrective Action and Underground Storage Tank Sites November 1997*, OSWER Directive 9200.4-17P (EPA 1999). This OSWER directive identifies three lines of evidence for evaluating MNA:

- Site data that clearly indicate the plume is shrinking or stable before impacting receptors
- Site data that identify the natural attenuation process and rate of these processes relative to reaching remediation goals
- Laboratory or field tests that quantify specific natural attenuation processes and rates.

If site data are insufficient to develop the first line of evidence, then the second and third lines of evidence need to be developed with a sufficient technical basis to support remediation decisions.

Specific steps for determining whether MNA can meet remediation goals for chlorinated solvents are provided in *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (EPA MNA protocol) (EPA 1998). Briefly, this protocol outlines data and analysis requirements that include the following:

- Site characterization
- An initial screening assessment to verify that site conditions are consistent with the conditions needed for natural attenuation processes
- Developing lines of evidence that natural attenuation is occurring demonstrating (e.g., through fate and transport modeling) that natural attenuation is likely to mitigate plume migration and meet remediation goals.

If MNA is selected as the remedy, it is implemented using a monitoring plan designed to verify that natural attenuation processes continue to attenuate the plume and that remediation goals are met over time.

Current DOE Office of Environmental Management efforts include a project focused on providing improved approaches for evaluating and implementing MNA (DOE-EM MNA Project). The primary approach identified by this project involves assessing plume-contaminant loading and the attenuation capacity within the groundwater-flow setting to determine whether the natural attenuation processes will effectively mitigate plume migration. This approach requires specific types of characterization data and analyses that are consistent with the current EPA MNA protocol.

Accelerated natural attenuation is another alternative that will be evaluated. This alternative uses a metals remediation compound for accelerating in situ metals cleanup in groundwater systems. One method of accelerating natural attenuation is through metals immobilization, where highly mobile metals in the aqueous phase are transferred to a solid stable phase that becomes part of the soil. The most common mechanisms of in situ metals immobilization are metals absorption to soil particles or precipitation of metal solids that are chemically fixed to soil particles.

6.4.4 Pump-and-Treat

The pump-and-treat alternative entails the design and implementation of an onsite system to accelerate removal and decrease the size of contaminant plumes. The objective of the pump-and-treat system would be to capture the groundwater contaminant plume using extraction wells to prevent further contaminant migration, treat the extracted water onsite, then re-inject the treated water upgradient of the groundwater plume. This alternative would evaluate the option of using one or more agents to assist in mobilizing selected contaminants then capturing the contaminants with the downgradient extraction wells. This alternative would need to be supported by groundwater modeling to define the optimum location for the extraction wells and to ensure that the plume is fully captured. Pump-and-treat systems usually include liquid and vapor-phase filters that require regeneration and/or disposal.

6.4.5 Permeable or Impermeable Containment

The intent of the permeable or impermeable containment alternative is to contain groundwater contamination through the use of either permeable or impermeable barriers. Examples of permeable barriers include the in situ redox manipulation technology and vertical hydraulic fracturing. The in situ redox manipulation technology creates a permeable treatment zone that removes contaminants from the groundwater by converting the contaminants to a different valence state that is less hazardous. Contaminants in groundwater flowing through the treated zone are then converted to a less hazardous form.

Vertical hydraulic fracturing is a second method that could be used to install a permeable iron-reactive barrier. This reactive barrier would be installed perpendicular to the groundwater flow direction using hydraulic fracturing technology. Similar to in situ redox manipulation, wells would be installed at 4.6- to 15.2-m (15- to 50-ft) spacing across the downgradient edge of the contaminant plume, creating vertical fracturing in the formation. Iron filings are then injected into the vertical fractures to complete the permeable barrier. Sheet piling is often driven into the aquifer to re-direct the groundwater to flow through the iron-reactive barrier. As the contaminants pass through the permeable barrier, their valance state is changed, making them less hazardous.

Impermeable barriers that could be considered include the use of a cryogenic coil barrier, sheet piling, or grout curtain, or creating a groundwater mount using injected clean water. Cryogenic coils could either be used to freeze the entire contaminant plume in place or could be used to create a frozen wall of groundwater that would prevent the downgradient migration of the contaminant plume. Sheet piling or a grout curtain could either be used in combination with a permeable barrier or by itself. In the former case, sheet piling or a grout curtain could be used to channel groundwater towards a permeable barrier. In the latter case, sheet piling or a grout curtain could be used by itself to create an impermeable barrier that would trap the plume preventing migration. Finally, a number of injection wells could be installed downgradient of the contaminant plume. Injecting clean water into these wells would create a wall that would contain the plume. The use of impermeable barriers to control the migration of contamination would need to be combined with some form of institutional controls to prevent the usage of contaminated groundwater within the contained area.

6.5 PROPOSED PLAN

The proposed plan will identify a preferred alternative and present the alternative to the public for review and comment. The proposed plan also will provide a summary of the investigations for the 200-PO-1 Groundwater OU, the data generated from the various investigations, and the conclusions derived from the data. The proposed plan also will summarize the results of the FS and the basis for the action(s) proposed to remediate the site. It will include a summary of the remedial action and a schedule for implementation.

6.6 COMMUNITY RELATIONS

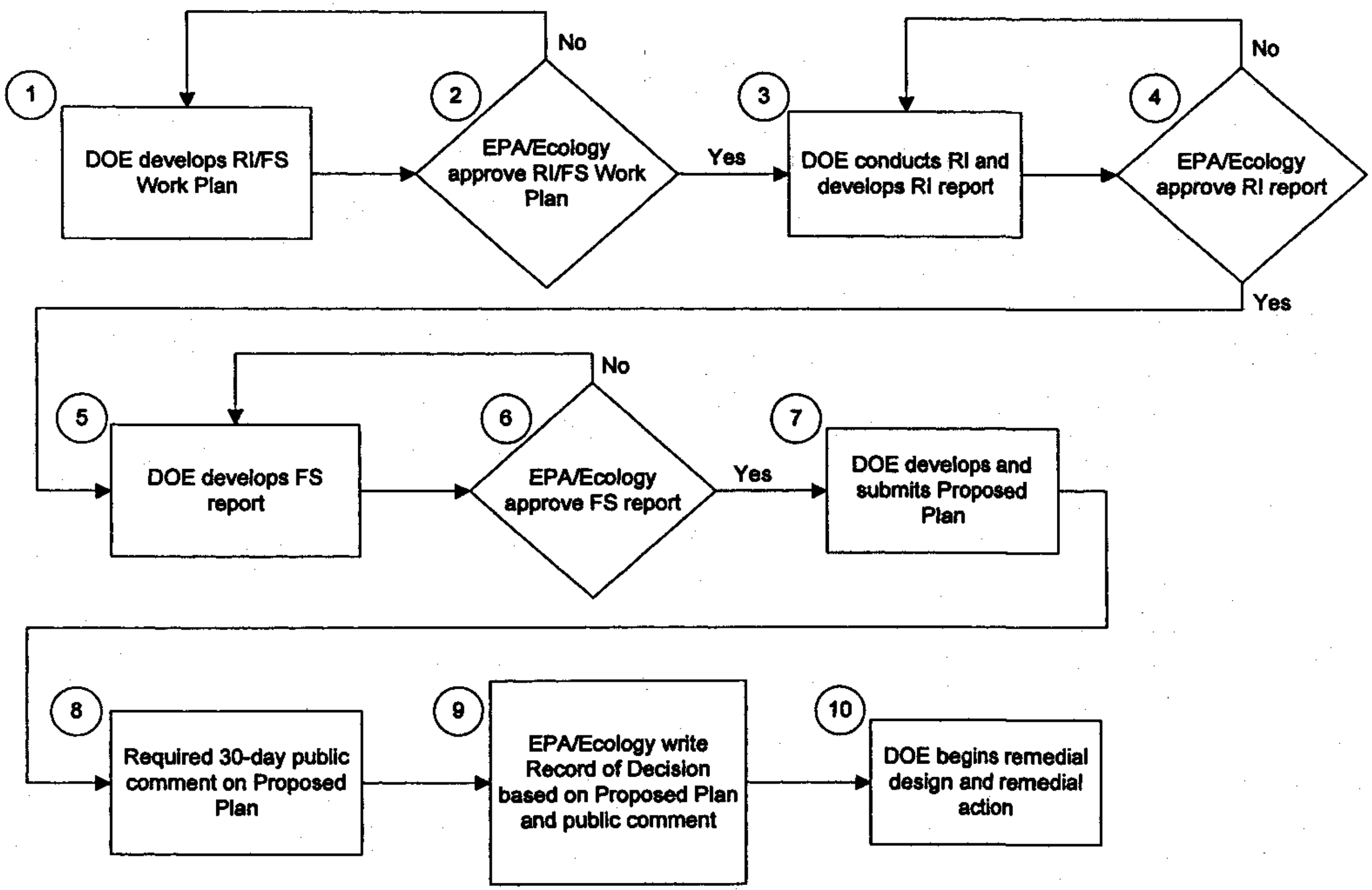
The *Hanford Site Tri-Party Agreement Community Relations Plan* (DOE 2002b) outlines the public participation processes implemented by the Tri-Parties under authority of the Tri-Party Agreement (Ecology et al., 1989) and identifies several ways the public can participate in the Hanford Site cleanup decision-making process. These participation outlets include contact information, how to obtain publications on Hanford cleanup activities, news media activities, public involvement and comment, etc. The Community Relations Plan can be accessed on the Internet at http://www.hanford.gov/?page=113&parent=91 .

The Tri-Parties conduct public involvement and information activities both cooperatively and independently. The Community Relations Plan intends to fulfill applicable state and Federal laws regarding development of community involvement and public participation plans. The plan also serves as one of the overall public participation plans guiding public involvement at the Hanford Site. Additional project-specific public participation plans are developed as needed at the Hanford Site. For the 200-PO-1 Groundwater OU Project, a project-specific community relations plan, is not planned to be developed because the project is not technically complex nor has it attracted sufficient public interest up to this point in time to warrant the development of a specific plan.

Under CERCLA, a plan is developed for remediation of each waste site. The best technology is selected after a thorough study of the characteristics of that site. The decision process is shown on the flowchart in Figure 6-1. In the CERCLA process, the proposed cleanup plan must undergo a 30-day public comment period before a decision is made. A public meeting may be requested on the plan during the comment period by contacting the Hanford Cleanup Line at 1-800-321-2008.

This document will be placed in information repositories as listed in the *Hanford Site Tri-Party Agreement Community Relations Plan* (DOE 2002b).

Figure 6-1. Tri-Party Agreement *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* Remedial Investigation/Feasibility Study Decision Process (DOE et al., 2002b).



DOE = U.S. Department of Energy.
Ecology = Washington State Department of Ecology.
EPA = U.S. Environmental Protection Agency.
RI/FS = remedial investigation/feasibility study.

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7.0 PROJECT SCHEDULE AND KEY ASSUMPTIONS

Tri-Party Agreement Milestone M-013-10A (Ecology et al., 1989) requires the submission of 200 Area RI/FS Work Plans by September 31, 2007. Milestones M-015-00 and M-15-00C require completion of the pre-ROD 200 Area RI/FS process for all non-tank farm OUs by December 31, 2011. Tri-Party Agreement Milestone M-016-00 requires the completion of remedial actions for all non-tank farm OUs by September 30, 2024. The following interim milestones for the 200-PO-1 Groundwater OU are presented:

- Submit a Remedial Investigation Report by September 30, 2010.
- Submit a Feasibility Study Report and Proposed Plan by December 31, 2011.

The project schedule for activities discussed in this Work Plan is provided in Figure 7-1 and is consistent with Tri-Party Agreement milestones. This schedule will serve as the baseline for the work planning process and will be used to measure the progress of implementation of this process. The schedule for the RI activities and the preparation, review, and issuance of the RI report, the FS, and the proposed plan also are shown in Figure 7-1. The schedule concludes with the preparation of a ROD.

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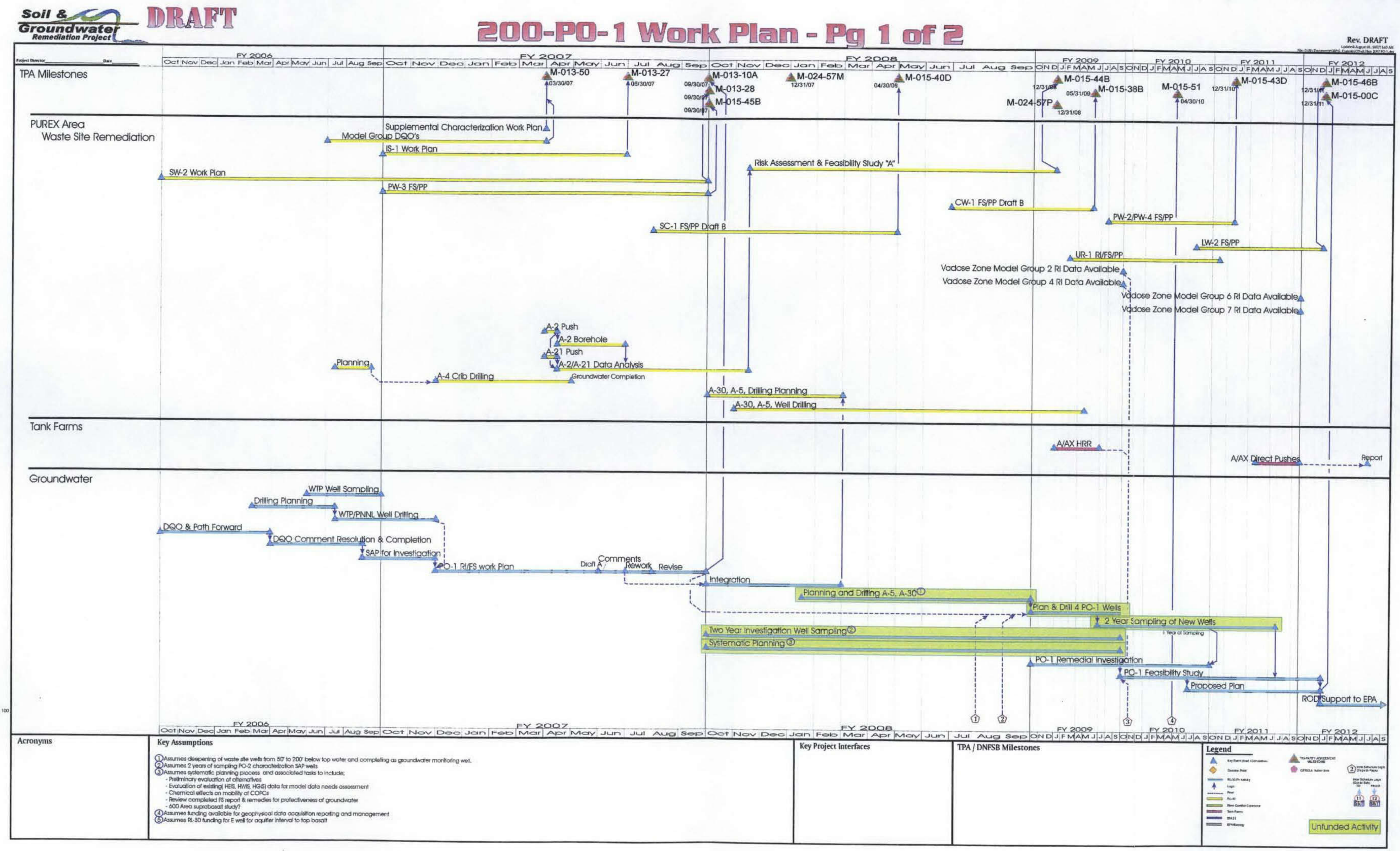
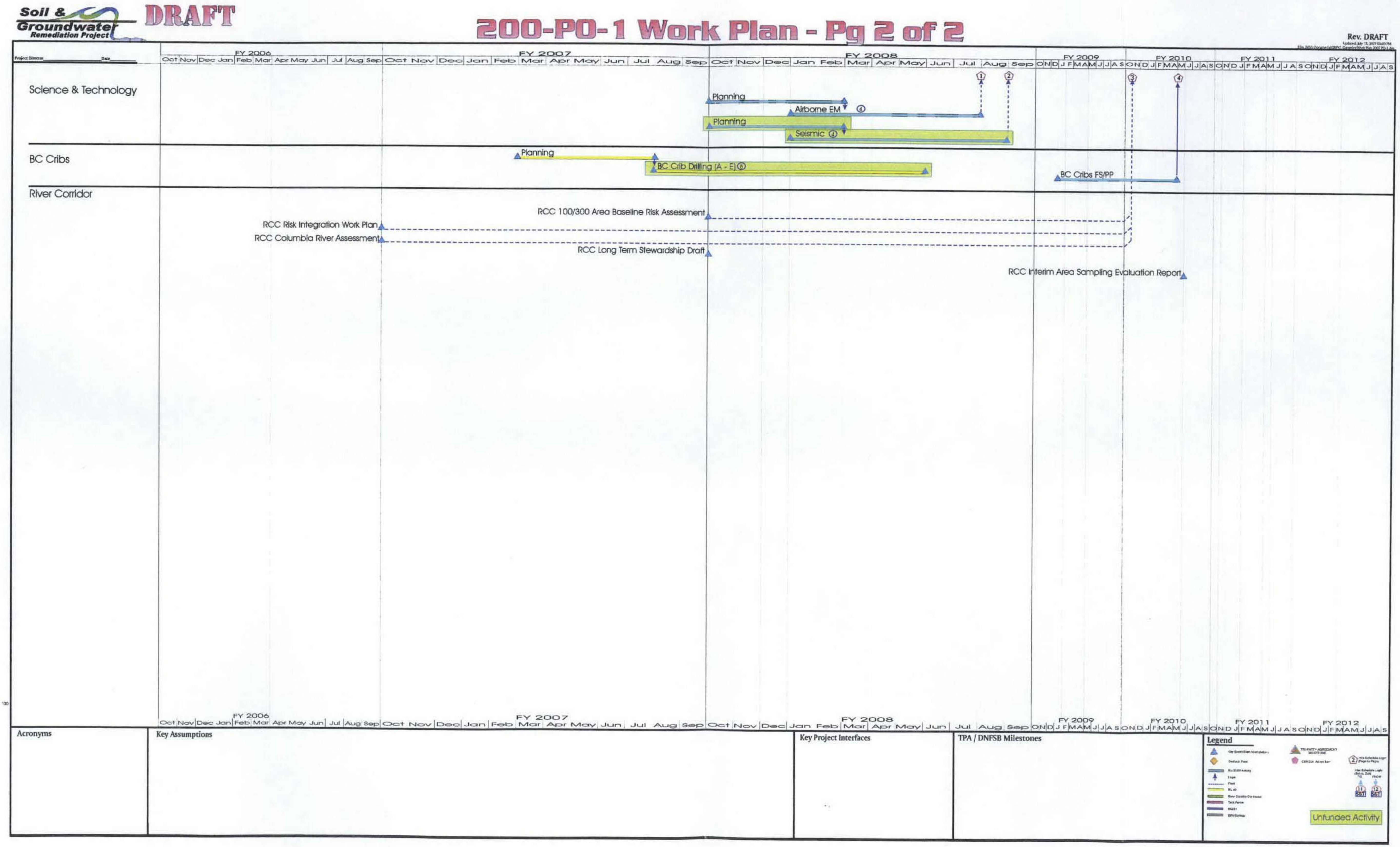


Figure 7-1. Project Schedule Page 1 for Remedial Investigation/Feasibility Study Activities.

Figure 7-2. Project Schedule Page 2 for Remedial Investigation/Feasibility Study Activities.



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APPENDIX A

SAMPLING AND ANALYSIS PLAN FOR REMEDIAL INVESTIGATION AND CHARACTERIZATION OF THE 200-P0-1 GROUNDWATER OPERABLE UNIT

CONCURRENCE PAGE

Title: Sampling and Analysis Plan for Remedial Investigation and Characterization of the 200-PO-1 Groundwater Operable Unit

Concurrence: David A. Brockman, Manager
U.S. Department of Energy, Richland Operations Office

Signature ______________________ Date __________

Matthew S. McCormick, Assistant Manager for the Central Plateau
U.S. Department of Energy, Richland Operations Office

Signature ______________________ Date __________

John Price, Project Manager
Washington State Department of Ecology

Signature ______________________ Date __________

Rod Lobos, Project Manager
Environmental Protection Agency

Signature ______________________ Date __________

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FIGURES

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TERMS

AEA	alpha energy analysis
SAC	Chemical Abstracts Service
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DST	double-shell tank
DWS	drinking-water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERC	electrical-resistivity characterization
FH	Fluor Hanford, Inc.
GEA	gamma energy analysis
GPC	gas-proportional counting
HEIS	*Hanford Environmental Information System* database
IC	ion chromatography
ICP	inductively coupled plasma
LSC	liquid-scintillation counting
MCL	maximum contaminant level
N/A	not applicable
NRDWL	Nonradioactive Dangerous Waste Landfill
OU	operable unit
PC	potential contribution
PRG	preliminary remediation goal
PUREX	Plutonium-Uranium Extraction (Plant or process)
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RI/FS	remedial investigation/feasibility study
RL	Richland Operations Office
RQL	required quantitation limit
RT	river transect
SAP	sampling and analysis plan
SET	south-east transect
SST	single-shell tank
TBD	to be determined
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)
VOA	volatile organic analysis
Work Plan	*Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit* (DOE/RL-2007-31)

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

A1.0 INTRODUCTION

This sampling and analysis plan (SAP) presents a multi-faceted program of characterization for the 200-PO-1 Groundwater Operable Unit (200-PO-1 groundwater OU) remedial investigation/feasibility study (RI/FS). The program is designed to complement the groundwater monitoring SAP (DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*) and is intended to yield new information regarding groundwater flow rates, preferential pathways for contaminant migration, and contaminant mass transport. In addition, some aspects of the SAP will supplement site-specific vadose zone characterization for the purpose of estimating future threats to groundwater quality from existing vadose zone contamination.

This SAP encompasses field methods other than those routinely applied for groundwater monitoring at the Hanford Site. The general objectives of the characterization program include the following:

- Determine the three-dimensional distribution of groundwater contaminants and hydraulic flow parameters using depth-discrete sampling and analysis, depth-discrete hydrologic testing, and geophysical estimation of flow parameters.
- Use geophysical methods to map structures in basalts and suprabasalt sediments that may control groundwater flow.
- Apply single-well geochemical tracer methods or alternative instrumental methods to map hydraulic conductivity (and relative flow velocity) in selected monitoring wells.
- Use geophysical methods to map conductive contaminant plumes at waste disposal sites.

The end products of the 200-PO-1 Groundwater OU RI/FS will be an estimate of environmental risk posed by groundwater contaminants in the 200-PO-1 Groundwater OU and an evaluation of available remedial alternatives in terms of achievable risk reduction and realistic economics. The measurements inherent in the above general objectives, in conjunction with data from routine sampling and analysis, will provide the "ground truth" needed for estimating present environmental risk and will augment the existing database used for groundwater transport modeling, thereby increasing the reliability of estimates of future environmental risk. In addition, the measurements will serve as the basis for reasonable engineering evaluation of remedial alternatives in the following ways:

- Identifying significant preferential groundwater and contaminant flowpaths, which is critical for determining *where* engineered remedial solutions would be most effectively applied
- Depth-discrete profiling of the contaminant burden of the groundwater, which is critical for determining the *design scale* for engineered remedial solutions, for evaluation of various treatment technologies, and for realistic cost/benefit calculations

- Depth-discrete profiling of hydraulic parameters, which is necessary to predict the *hydraulic response* of contaminated intervals of the aquifer to pumping and injecting of water for collecting, treating, or isolating contamination
- Vertical profiling and flow-mapping together provide the means to estimate the rate of *groundwater and contaminant mass transport*, which is yet another factor affecting design scale, and which is necessary for environmental risk assessment (e.g., risk associated with transport of contaminants from the OU into the Columbia River).

The results of characterization under this SAP will be used for a planned revision to the existing groundwater monitoring SAP noted above.

A1.1 200-PO-1 GROUNDWATER OPERABLE UNIT DESCRIPTION

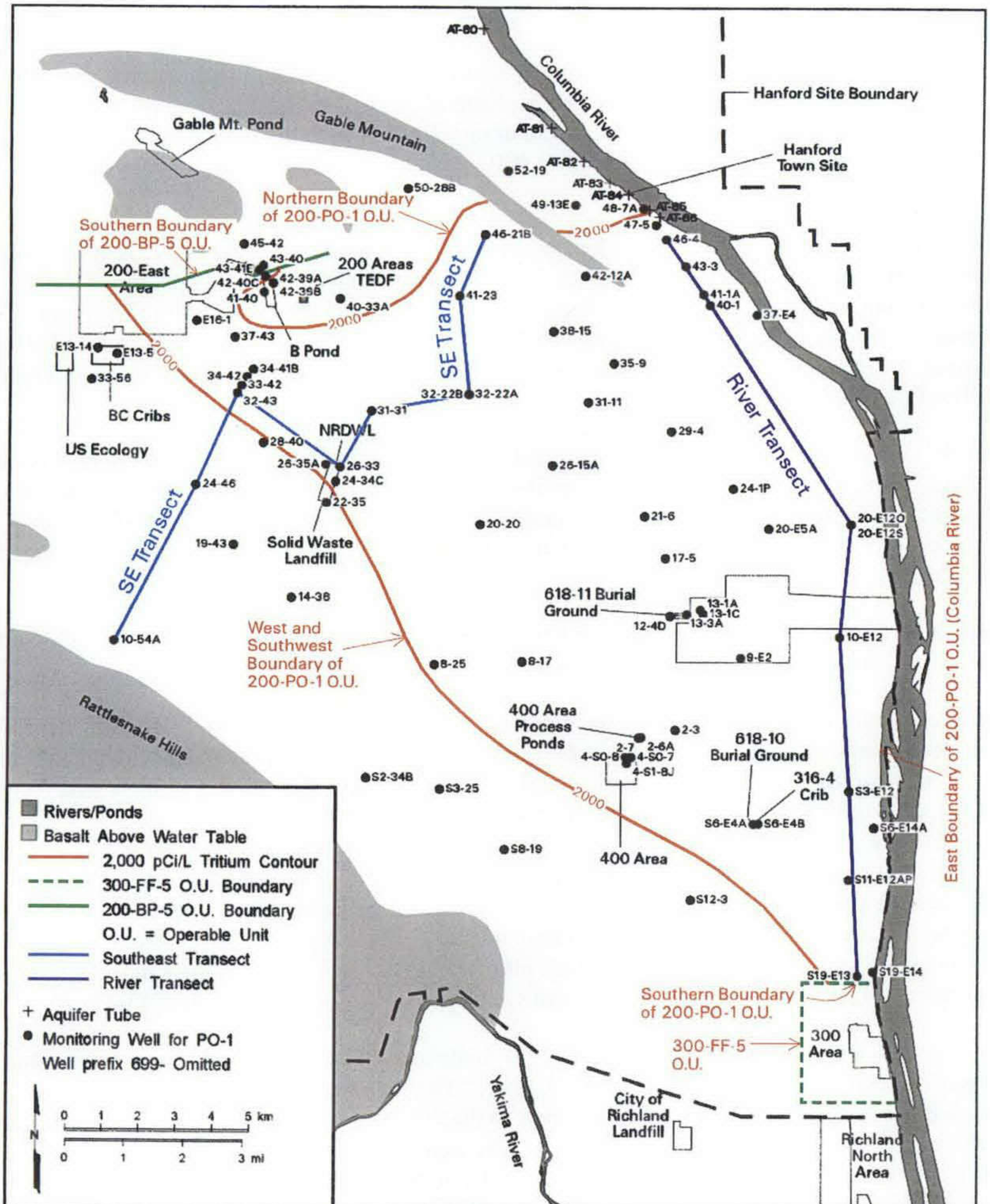
Figure A1-1 depicts the 200-PO-1 Groundwater OU boundary, associated major facilities, and current groundwater monitoring well and aquifer tube locations. The 200-PO-1 Groundwater OU is the largest groundwater OU associated with the Hanford Site. The 200-PO-1 Groundwater OU encompasses the southern part of the 200 East Area and a large triangle-shaped section of the Hanford Site, extending to the Hanford Town Site to the east and the 300-FF-5 Groundwater OU to the southeast. At the present time, two different boundaries sets are used for the 200-PO-1 Groundwater OU. One of the currently applied boundaries is geographically defined; the other boundary includes a 2,000 pCi/L isopleth for a groundwater tritium plume in the southeast portion of the unconfined aquifer within 200-PO-1 Groundwater OU. The associated tritium groundwater plume extends eastward and southward from potential contaminant sources in the southern portion of the 200 East Area. The geographic boundaries of the 200-PO-1 Groundwater OU are the Columbia River to the east; the 300-FF-5 Groundwater OU to the south; and the 200-BP-5 Groundwater OU to the north.

Included within the 200-PO-1 Groundwater OU are six *Resource Conservation and Recovery Act of 1976* (RCRA) units including the Plutonium-Uranium Extraction (PUREX) Plant cribs, Waste Management Area A-AX (single-shell tanks), 216-A-29 Ditch, Integrated Disposal Facility, 216-B-3 Pond (B Pond), and the Nonradioactive Dangerous Waste Landfill (NRDWL). Three other facilities that are not regulated under RCRA but are subject to *Washington Administrative Code* requirements are the 200 Areas Treated Effluent Disposal Facility, Solid Waste Landfill, and 400 Area process ponds.

Groundwater contamination in the 200-PO-1 Groundwater OU primarily is related to waste disposal associated with PUREX Plant operations. The PUREX process used tributyl phosphate in normal paraffin hydrocarbon solvent to recover uranium and plutonium from irradiated fuel rods dissolved in nitric acid (DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*). The plant operated from 1955 to 1972 and again from 1983 to 1992, when it was officially closed.

Figure A1-1. 200-PO-1 Groundwater Operable Unit Showing Monitoring Wells.

After PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*



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Low-level PUREX waste was disposed to liquid waste disposal units such as cribs, trenches, and french drains, whereas high-level waste was contained in the tank farms. Process waste discharges to the south and east of the PUREX facility are affecting groundwater quality over a large area.

Groundwater contaminant plumes currently existing in the 200-PO-1 Groundwater OU are summarized below (PNNL-16346).

The most extensive and significant contaminants are plumes of I-129, nitrate, and tritium. The I-129 and nitrate plumes generally coincide in shape and extent with the tritium plume. These plumes have reached the Columbia River; the nitrate discharges to the river generally are below the U.S. Environmental Protection Agency's (EPA) drinking water maximum contaminant levels (MCL).

Minor plumes of Sr-90 and Tc-99 are located in or adjacent to the 200 East Area. A small Sr-90 plume exists near the 216-A-10 and 216-A-36 Cribs, with one well showing contamination above the 8 pCi/L MCL. Technetium-99 groundwater concentrations just east of the Waste Management Area A-AX Tank Farm are above the 900 pCi/L MCL. Figures A1-2 and A1-3 illustrate the extent of major radionuclide and hazardous chemical contaminants, respectively, on the Hanford Site (PNNL-16346).

The BC Cribs and Trenches Area, while outside of the 200-PO-1 Groundwater OU boundary, are potential sources of contamination. The limited groundwater monitoring performed to date has not indicated significant groundwater contamination in the area, but contaminants of potential future concern from the BC Cribs and Trenches Area include Tc-99, chromium, Co-60, cyanide, and uranium.

Tetrachloroethylene was the only organic constituent found within one or more wells at the Solid Waste Landfill that was consistently above the MCL (0.8 μg/L).

Bands of "guard wells," chosen from the monitoring network of the 200-PO-1 Groundwater OU, have been established. These "guard wells" (shown in Figure A1-1), consisting of two bands of wells, are sampled annually at a minimum and are used to detect and monitor plumes emanating from waste sites in the 200-PO-1 Groundwater OU. One band, the Southeast Transect (SET), is located to the south and east of the 200 East Area and detects contamination moving into the southern and eastern parts of the Hanford Site (PNNL-16346). A second band, the River Transect (RT), is positioned along the Columbia River at the eastern edge of the Hanford Site to monitor contaminant transport into the Columbia River. These wells are sampled annually at a minimum and are used to detect and monitor plumes emanating from waste sites in the 200-PO-1 Groundwater OU. The locations of the guard well transects are shown in Figure A1-1.

For the purposes of this report, the 200-PO-1 Groundwater OU is divided into three geographic areas of concern (see Figure 4-1 in the Work Plan). The first area, or "near-field" region, represents the source areas within and adjacent to the 200 East Area, and the downgradient areas to and including the SET. The second area, or "far-field" region, is defined as the area of the 200-PO-1 Groundwater OU extending from the SET to the Columbia River. The RT, a subset of the far-field region, represents the third area of concern.

Figure A1-2. Radionuclide Contamination in Groundwater at the Hanford Site.

After PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*

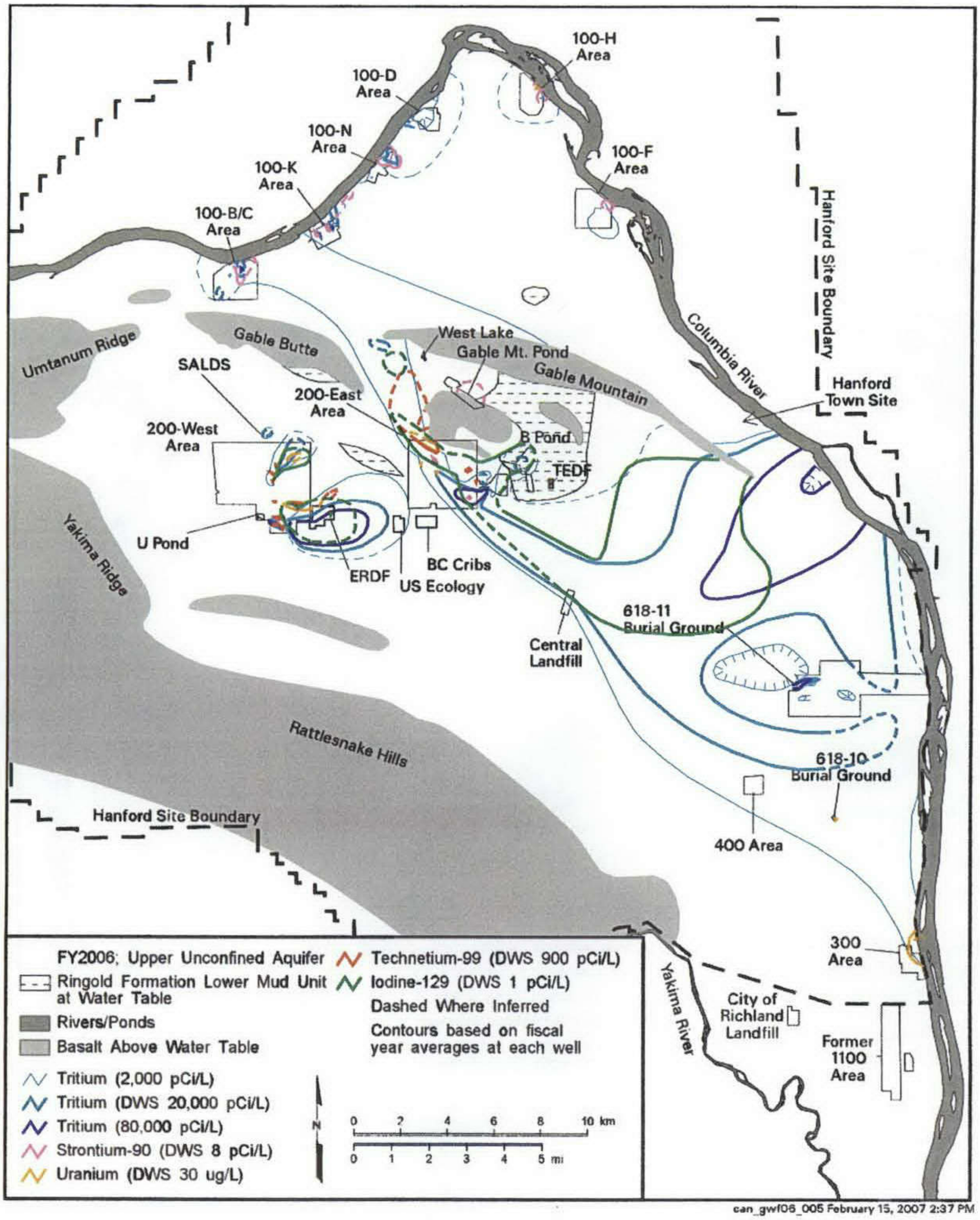
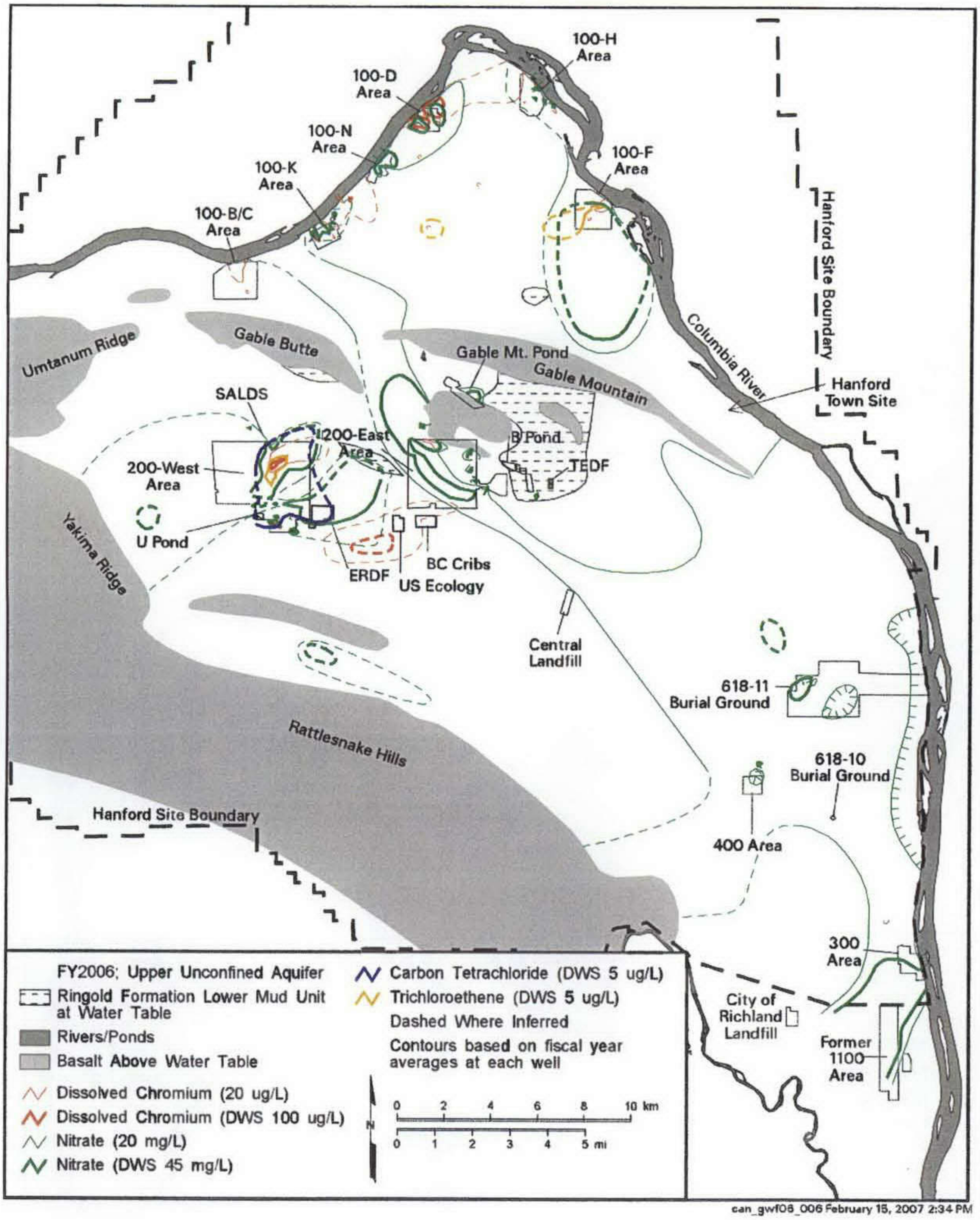


Figure A1-3. Hazardous Chemical Contamination in Groundwater at the Hanford Site.

After PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*



The far-field groundwater contaminants of concern are tritium, I-129, and nitrate. Concentrations of nitrate (expressed as nitrate) that exceed the 45 mg/L drinking water standard, and of I-129 that exceed the minimum required detection level, are within the 2000 pCi/L tritium boundary isopleths, Figures A1-2 and A1-3 (PNNL-16346). Note that the 45 mg/L drinking water standard for total nitrate also may be expressed as nitrogen in nitrate with a 10 mg/L MCL.

Near-field monitoring is associated primarily with treatment, storage, and disposal (TSD) facilities and includes the BC Cribs and Trenches Area. The near-field contaminant plumes (other than tritium, I-129, and nitrate) generally are localized and limited to specific source OUs.

A1.2 SOURCE WASTE SITES

In the 200-PO-1 Groundwater OU, widespread distribution of waste constituents in groundwater is limited to tritium, nitrate, and I-129. Smaller contaminant concentrations in groundwater beneath individual source sites represent several additional waste constituents. In contrast, the list of contaminants in liquid wastes to the soil column is extensive. The great majority of those individual substances have not reached/contaminated the groundwater within the 200-PO-1 Groundwater OU. While some individual waste constituents will have decayed (i.e., radionuclides with a short half-life) or chemically degraded, other components of the waste stream remain in the vadose zone.

One of the objectives of the characterization program described here is to use geophysical methods to map the position and physical extent of vadose zone contamination at selected sites. Such data will be useful for evaluating the likelihood of future threats to the groundwater and for remediating individual waste sites.

Table A1-1 lists the source OUs within the 200-PO-1 Groundwater OU and shows individual waste sites within each source OU. The table includes waste sources that apparently are upgradient of, or overlie, the 200-PO-1 Groundwater OU but may pose a threat to its groundwater quality. For many of the sites, the table includes an assessment of the likelihood that the liquid waste has reached groundwater (DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report*). The assessments are based on the volume of liquid disposed of compared to the pore volume of the underlying vadose zone sediments and on geophysical logging data (where available).

Table A1-1. Waste Sites Above the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC
Cribs			Trenches			French Drains	Nitrate		Septic Systems		
216-A-1	PW-2	N	216-A-18	PW-2	Y	216-A-11	MW-1	Y	2607-E6	ST-1[b]	N
216-A-2	PW-3	N	216-A-19	PW-2	Y	216-A-12	MW-1	Y	2607-E7	ST-1[b]	N
216-A-3	PW-2	Y	216-A-20	PW-2	Y	216-A-13	MW-1	Y	2607-E8	ST-1[b]	N
216-A-4	MW-1	Y	216-A-40	CW-1	N	216-A-14	MW-1	N	2607-E11	ST-1[b]	N
216-A-5	PW-2	Y	216-B-20	TW-1[a]	Y	216-A-15	LW-2	Y	2607-E12	ST-1[b]	N

Table A1-1. Waste Sites Above the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC
216-A-6	SC-1	Y	216-B-21	TW-1[a]	Y	216-A-16	PO-3	Y	2607-EE	ST-1[b]	N
216-A-7	PW-3	Y	216-B-22	TW-1[a]	Y	216-A-17	PO-3	Y	2607-EK	ST-1[b]	N
216-A-8	PW-3	Y	216-B-23	TW-1[a]	Y	216-A-23A	PO-3	N	2607-EL	ST-1[b]	N
216-A-9	CW-1	Y	216-B-24	TW-1[a]	Y	216-A-23B	PO-3	N	2607-EM	ST-1[b]	N
216-A-10	PW-2	Y	216-B-25	TW-1[a]	N	216-A-22	MW-1	N	2607-EN	ST-1[b]	N
216-A-21	MW-1	Y	216-B-26	TW-1[a]	Y	216-A-26	MW-1	Y	2607-EO	ST-1[b]	N
216-A-24	PW-3	Y	216-B-27	TW-1[a]	N	216-A-26-A	MW-1	Y	2607-EP	ST-1[b]	N
216-A-27	MW-1	Y	216-B-28	TW-1[a]	Y	216-A-28	PW-2	Y	2607-EQ	ST-1[b]	N
216-A-30	SC-1	Y	216-B-29	TW-1[a]	Y	216-A-33	MW-1	N	2607-ER	ST-1[b]	N
216-A-31	PW-3	N	216-B-30	TW-1[a]	Y	216-A-35	MW-1	N	2607-ER1	ST-1[b]	N
216-A-32	MW-1	N	216-B-31	TW-1[a]	N			N	2607-EZ	ST-1[b]	N
216-A-36-A	PW-2	Y	216-B-32	TW-1[a]	Y	**Ponds**			2607-GF	ST-1[b]	N
216-A-36-B	PW-2	Y	216-B-33	TW-1[a]	Y	216-B-3	CW-1	Y			
216-A-37-1	PW-4	Y	216-B-34	TW-1[a]	Y	21-6B-3A, B, C	CW-1	N	**Unplanned Releases**		
216-A-37-2	SC-1	Y	216-B-52	TW-1[a]	Y	2101-M Pond	CW-1	N	200-E-43	UR-1	N
216-A-38-1	MW-1	N	216-B-53-A	TW-1[a]	Y				200-E-44	UR-1	N
216-A-39	PO-3	N	216-B-53-B	TW-1[a]	N	**Ditches**			200-E-103	UR-1	N
216-A-41	MW-1	N	216-B-54	TW-1[a]	N	216-A-29	CS-1	Y	200-E-107	UR-1	N
216-A-45	PW-4	Y	216-B-58	TW-1[a]	N	216-A-34	PW-4	N	UPR-200-E-10	UR-1	N
216-B-14	TW-1[a]	Y			N				UPR-200-E-12	UR-1	N
216-B-15	TW-1[a]	Y	**Burial Sites**			**Tank Farms etc**			UPR-200-E-17	UR-1	N
216-B-16	TW-1[a]	Y	Nonradioactive			241-A (6)	SST	N	UPR-200-E-18	UR-1	N
216-B-17	TW-1[a]	Y	Dangerous			241-AP (7)	DST	N	UPR-200-E-19	UR-1	N
216-B-18	TW-1[a]	Y	Waste Landfill	SW-2	N	241-AW (6)	DST	N	UPR-200-E-29	UR-1	N
216-B-19	TW-1[a]	Y				241-AX (4)	SST	N	UPR-200-E-33	UR-1	N
			Solid Waste			241-AY (2)	DST	N	UPR-200-E-36	UR-1	N
Retention Basins			216-E-1	SW-2	N	241-AZ (2)	DST	N	UPR-200-E-142	UR-1	N

Table A1-1. Waste Sites Above the 200-PO-1 Groundwater Operable Unit. (3 Pages)

Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC	Waste Site	OU	*PC
207-A-North	SC-1	N				Diversion Boxes			UPR-200-E-143	UR-1	N
207-A-South	SC-1	N									

[a] 200-TW-1 was changed to 200-BC-1 in 2007.
[b] 200-ST-1 was changed to 200-MG-1 in 2007.
*PC – Potential Contribution.
DST = double-shell tank.
OU = operable unit.
SST = single-shell tank.

A1.3 GEOLOGY AND HYDROGEOLOGY

The unconfined aquifer within the 200-PO-1 Groundwater OU occurs within the Hanford formation or underlying Ringold Formation. Groundwater flow in the unconfined aquifer generally is southeast and east toward the Columbia River. Confined or semiconfined aquifer conditions occur locally below the Ringold lower mud unit and within the Columbia River Basalts (DOE/RL-2003-04). In general, the Ringold confined aquifer below the lower mud unit and the uppermost basalt-confined aquifer is northeast to east (PNNL-16346).

The direction of groundwater flow and hydraulic gradient customarily are inferred from hydraulic head measurements, and the rate of groundwater mass transport is calculated from inferred gradient and measured hydraulic conductivity. However, such inferences and calculations are reliably accurate only for a homogeneous, isotropic aquifer, which clearly is not descriptive of the unconfined aquifer at the Hanford Site. Further, measurements of hydraulic conductivity at the Hanford Site generally are made using single-well stress tests, which effectively interrogate the aquifer only in the immediate vicinity of the test well. Finally, as seen in Figure A1-4, hydraulic gradients are extremely shallow over much of 200-PO-1 Groundwater OU, which adds considerable uncertainty to the inferred gradients. Figure A1-4 also shows those areas where basalt is above the water table and therefore serves to constrain groundwater flow. Figure A1-5 shows near-field water table contours in the 200 East Area and vicinity and the locations of monitoring wells.

Figure A1-6 is a simplified cross section illustrating the suprabasalt stratigraphy approximately along the axis of the principal lobe of the far-field tritium plume, which approaches the Columbia River north of the Energy Northwest power plant. Figure A1-6 shows that the suprabasalt sediments thin significantly toward the east, which is consistent with the increased hydraulic gradient near the river.

Figure A1-4. Hanford Site Water Table Elevations for April 2006.

After PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*

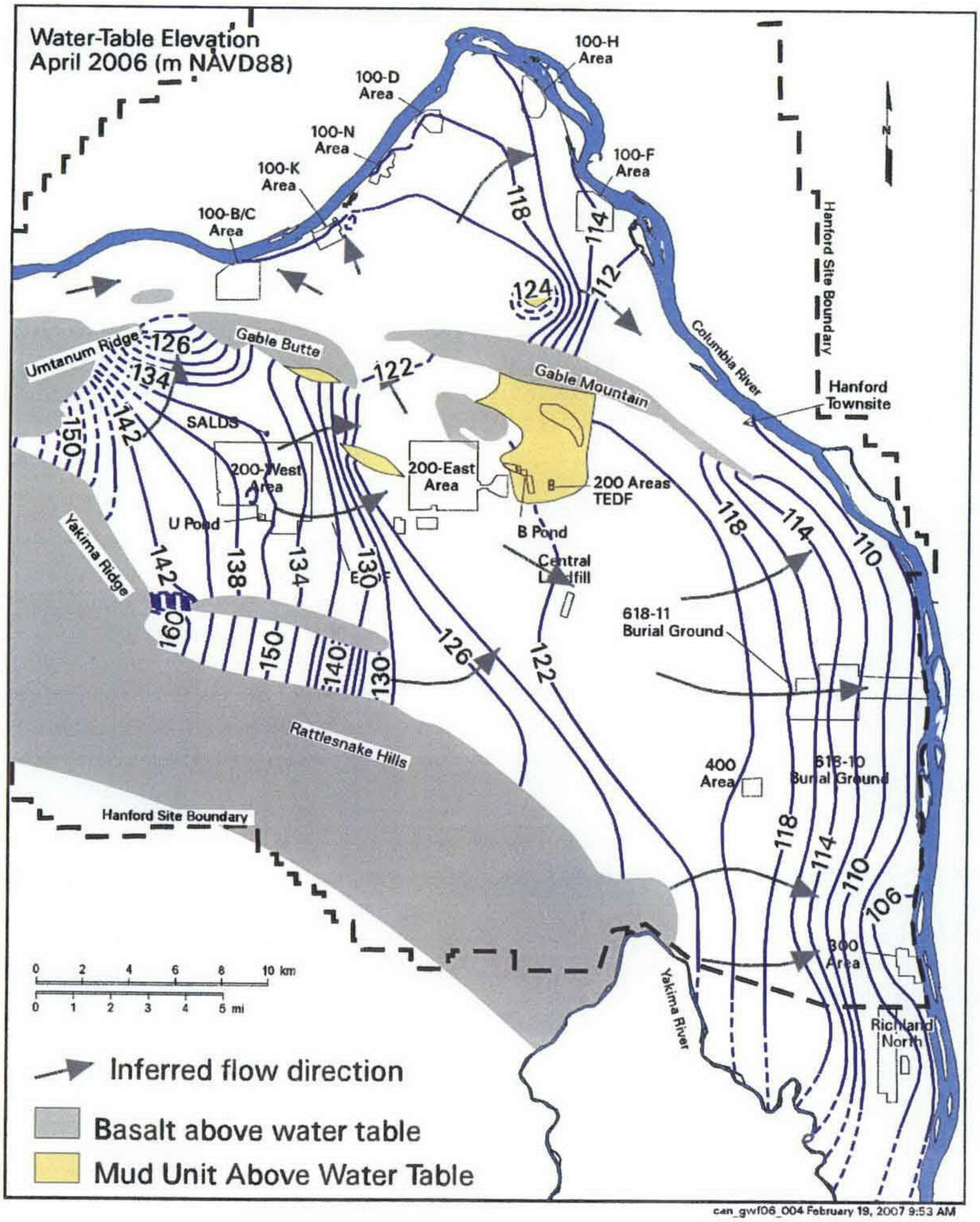


Figure A1-5. Water Table Elevations for the 200 East Area and Vicinity for July 2006.

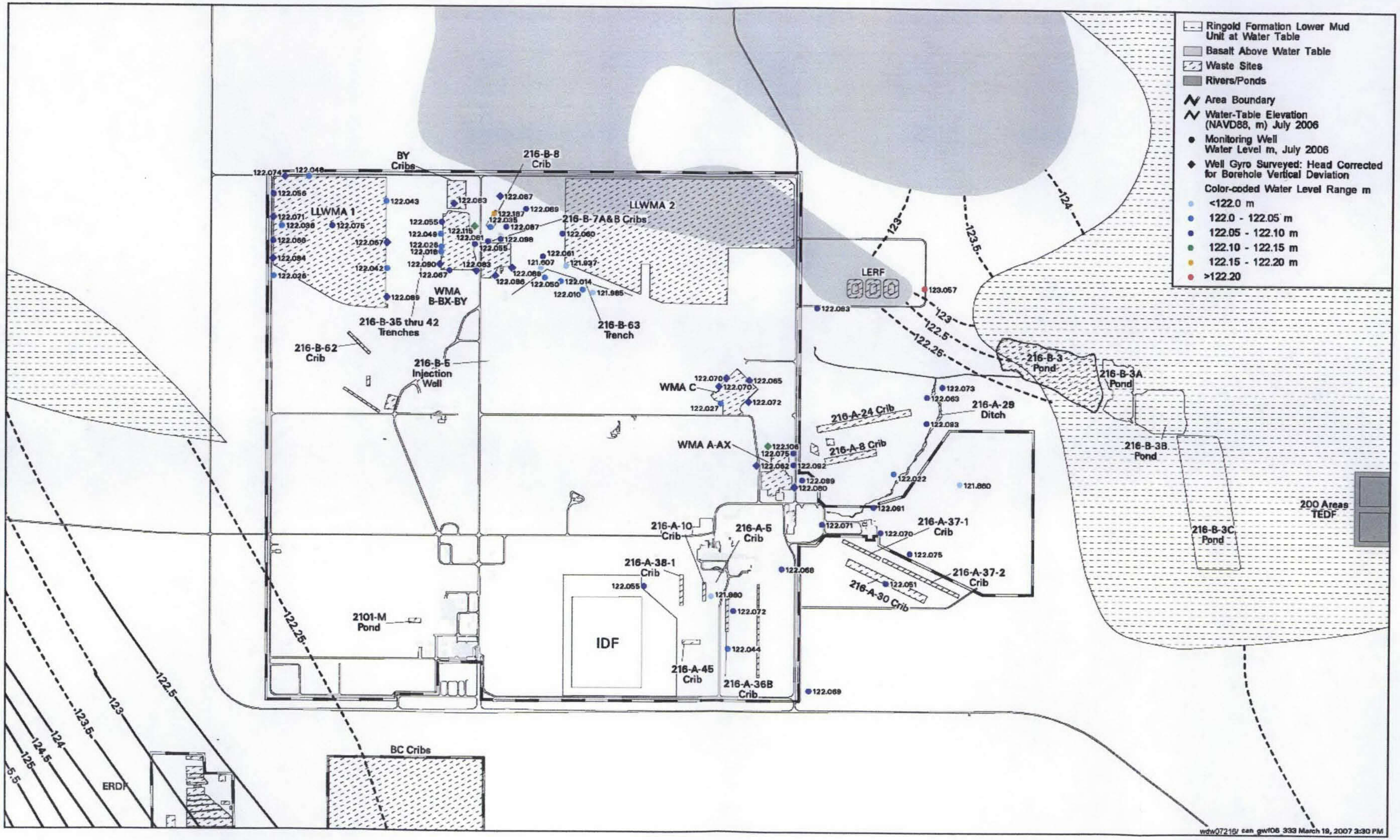
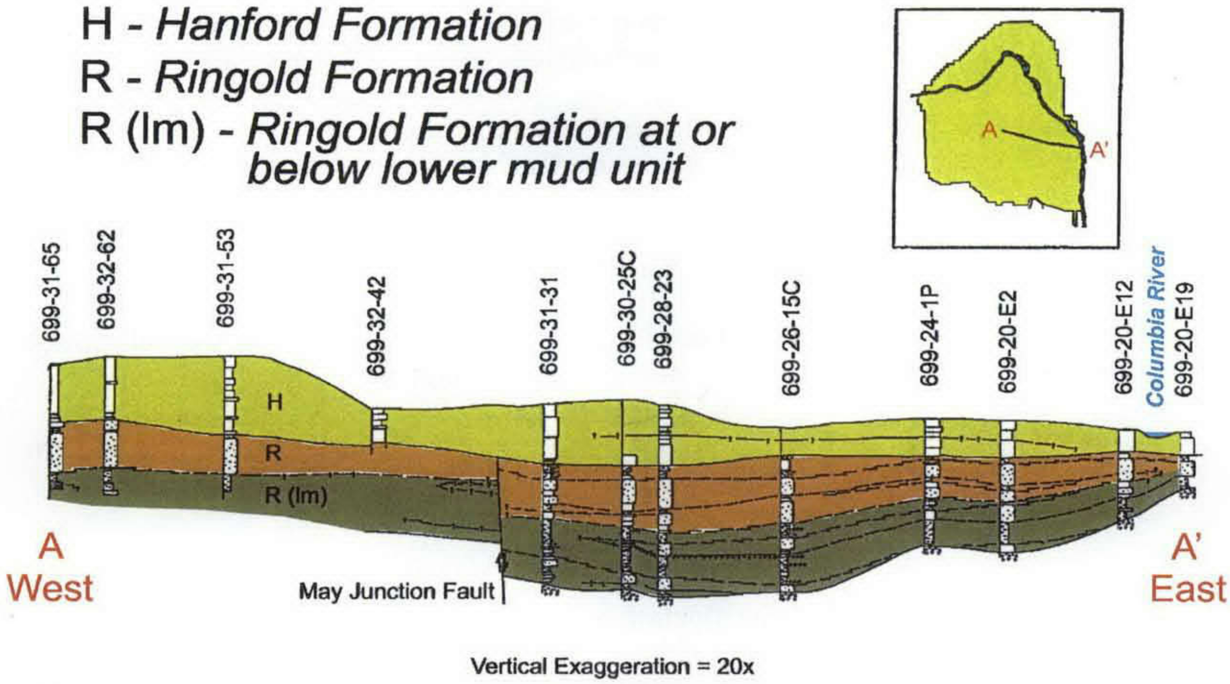


Figure A1-6. Geologic Cross Section of the Suprabasalt Sediments of the 200-PO-1 Groundwater Operable Unit from the 200 Areas to the Columbia River.



A1.4 SPECIFIC CHARACTERIZATION OBJECTIVES

Several specific characterization objectives have been identified to fulfill, in part, the general objectives of the 200-PO-1 Groundwater OU RI/FS. Some of the objectives listed below address contaminant distribution at known problematic sites, and others are intended to provide an initial demonstration and calibration of methods that are not used routinely, but which may prove to have general utility for Hanford Site characterization. The list of objectives includes locating the most appropriate sites for new sampling and testing points that will help identify preferential flowpaths of contaminants, define the extent of plume boundaries, and define the vertical and horizontal distribution of contaminants in the aquifer.

A1.4.1 Groundwater Flow Directions and Refining the Water Table Map

Determining groundwater flow direction in the southeastern portion of the 200 East Area (near the PUREX cribs) is difficult, because the water table there has an extremely low gradient. The gradient is so low that errors in measuring the depth to water are as large as or larger than the differences in water table elevations between the wells. As an example of the extremely low gradient in this region, two out of three wells measured in October 2006 had water table elevations within 0.1 m (0.32 ft). The wells all were measured in one day to decrease any barometric effects. The resulting data do not exhibit any statistically significant spatial trends and, therefore, cannot be used to determine the hydraulic gradient or flow directions. The solution is to decrease the amount of measurement error in determining water table elevations at wells (addresses PSQ-8). Other than errors caused by barometric effects, the two potential sources of significant measurement error are (1) the surveys that provided well locations and elevations and (2) the deviation of the wells from vertical. [Note: For an error of 0.1 m (0.328 ft), a 100 m (328 ft) well needs to be deviated only about 2.6 degrees from vertical].

Producing a corrected water table map of the southeastern portion of the 200 East Area and interpreting groundwater flow directions will be accomplished in the following three steps.

- Resurvey well locations using state of the art methods to reduce vertical error to no more than 2 to 3 mm (0.078 to 0.118 in.) in a 100 m (328 ft) well.
- Correct the depth to water measurements by checking the verticality of the wells using a down-hole gyroscope with an error of less than one degree.
- Conduct a trend surface analysis of the resulting water table map to separate local from regional variability and determine any regional trends on the water table surface (Davis, 2002, *Statistics and Data Analysis in Geology*, p. 397-415).

A1.4.2 River Transect Mass Transportation

Estimating the rate of mass transport of waste constituents through the 200-PO-1 Groundwater OU far-field area (600 Area) and toward the Columbia River is of importance for assessing environmental risk to the river. The RT wells are of particular interest, because they effectively establish a cross section or vertical "curtain" through which the waste constituents must pass to reach the river and because the saturated interval of the suprabasalt sediments is relatively thin compared to most of the 200-PO-1 Groundwater OU.

The RT wells lie within the area of thinner suprabasalt sediments and steeper hydraulic gradients. The shallower basement and relatively unambiguous gradients indicate that the RT may represent the most useful area within the 200-PO-1 Groundwater OU for initial application of a combined program of geophysical testing, single-well tracer testing, depth-discrete groundwater sampling, and supplementary hydraulic stress testing.

Estimates of mass transport will be based on depth-discrete sampling and analysis and *in situ* flow measurements, as well as on measured hydraulic conductivity. The span of cross section represented by each of the transect wells depends on well spacing. The need for additional and/or deepened wells will be determined by the results of initial depth-discrete sampling and analysis.

The combined results will be used for the purpose of estimating the net rate of contaminant transport from the 200-PO-1 Groundwater OU to the Columbia River. The estimate of contaminant mass transport would be independent of predictions based upon the sitewide groundwater flow model and therefore could be used as evidence for evaluating model validity.

A1.4.3 Application of Geophysical Methods

Noninvasive geophysical methods (see Section A1.5) will be used to characterize vadose zone contamination, deep vadose/suprabasalt paleochannels, faults, stratigraphy, and basalt surface topography.

A1.4.4 New Drilling

Up to four new wells will be required for the remedial investigation. The wells will be drilled through the saturated zone to the top of basalt for the purpose of developing depth-discrete contaminant, geotechnical, and hydrogeologic profiles.

A1.4.5 Aquifer Tubes

Aquifer tubes previously have been installed at some locations along the Columbia River shoreline (Figure A1-1). The purpose of the tubes is to detect waste constituents that are migrating from the 200-PO-1 Groundwater OU to the Columbia River and that may affect the river biota. Ten tentative locations between the Hanford Town Site and the 300 Area have been selected for installation of additional aquifer tubes (see Figure A3-7 in Section A3.9) to further characterize groundwater flowing off the Hanford Site to the river.

A1.5 SPECIALIZED CHARACTERIZATION METHODS

This section briefly introduces the capabilities and limitations of characterization methods that may be used to fulfill the objectives of the field testing program, but which are not routinely applied at the Hanford Site.

A1.5.1 Electrical Resistivity Characterization

Electrical resistivity characterization (ERC) measures the electrical resistance of soils and is capable of estimating the distribution of conductive contaminants in vadose zone soils. The ERC results are affected by cultural noise and variations in lithology, moisture, and the nature of contamination. Sensitivity is dependent on variations in electrical resistivity and moisture content in the vadose zone. The ERC at the BC Cribs and Trenches Area and several of the tank farms appears favorable, but is not yet fully evaluated (results are presented in PNNL-14948, *Plume Delineation in the BC Cribs and Trenches Area*, and RPP-RPT-28955, *Surface Geophysical Exploration of T Tank Farm at the Hanford Site*).

The waste inventory at the BC Cribs and Trenches Area suggests that mobile Tc-99 and nitrate eventually could reach groundwater, but neither the extent of the vadose zone plume nor its proximity to groundwater is known. The ERC survey at the BC Cribs and Trenches Area was performed to determine the distribution of Tc-99 and other contaminants of potential concern (COPC) within the vadose zone. If the full evaluation of the results demonstrates the feasibility of this method, it will be applied at other sites within the 200-PO-1 Groundwater OU, and the results will be used to help predict which source OUs pose future threats to groundwater quality.

A1.5.2 High-Resolution Reflection Seismic Method

The high-resolution reflection seismic method can be used to investigate subsurface geologic structure and stratigraphy for depths ranging from approximately 30 to 300 m (100 to 1,000 ft) below ground surface. The method requires accurate velocity models and may not resolve thin stratigraphic units.

A1.5.3 Airborne Electromagnetic Survey Method

The airborne electromagnetic survey method is useful for measuring thickness of clay layers, for delineating basement rock, and for identifying buried structures such as landfills, tanks, and pipelines. Airborne electromagnetic surveys can penetrate depths of up to 180 m (600 ft), but the method requires a line spacing of 300 to 510 m (1,000 to 1,700 ft) for high resolution.

A1.5.4 Borehole Geophysics

The results of a currently planned technology demonstration of innovative borehole geophysical methods that can be applied in steel-cased wells will determine which of the methods will be used to characterize selected wells in the 200-PO-1 Groundwater OU. The methods that will be demonstrated include the following:

- Active gamma
- Resistivity
- Neutron density
- Sonic log.

A1.5.5 Single-Well Geochemical Tracer Methods

Single-well tracer tests, in conjunction with depth-discrete groundwater sampling and analysis, can add a third dimension to the essentially two-dimensional results obtained by conventional sampling and hydraulic testing. Three-dimensional data can substantially improve the accuracy of groundwater flow modeling and site-specific mass transport calculations.

Two single-well tests that generally have proven useful and that have been demonstrated at the Hanford Site are the point-dilution test and the drift-and-pumpback test. The two tests can be performed independently or combined in a single field experiment.

The point-dilution test yields a profile of hydraulic conductivity in a screened well when the concentration of a tracer such as bromide is measured as a function of both time and depth. Only a small volume of a tracer solution concentrate needs to be introduced to the well bore, and the test (conducted under natural gradient) requires no pumping. A submersible instrument for tracer measurement, the test procedures, and typical results are described in "Single-well Tracer Tests in Aquifer Characterization" (Hall, 1993).

The drift-and-pumpback test originally was devised as a method for estimating flow velocity independent of gradient measurement and stress tests. Like the point-dilution test, the drift-and-pumpback test is initiated by introducing a small volume of tracer to the well bore. The tracer then is allowed to migrate from the well under natural hydraulic gradient, usually for a few days or longer, depending on local conditions. Finally, the tracer slug is recovered by pumping, and the tracer concentration in the pumped effluent is monitored as a function of time (assuming constant discharge). Interpretation of the test is based on the amount of pumping required to recover the center of mass of the tracer slug.

Just as with conventional hydrogeologic analysis, the test interpretation requires an estimate of effective porosity. However, "A Method for Estimating Effective Porosity and Ground-water Velocity" (Hall et al., 1991) showed that conventional test results plus the results of a drift-and-pumpback test together yield a unique estimate of the local effective porosity and groundwater velocity. Similarly, when point-dilution results are combined with the results of conventional methods, the tracer results can be recalibrated as a direct profile of aqueous mass transport.

The point-dilution calibration is valid for other wells of substantially similar construction, so the test could be used to investigate flow in those areas of the 200-PO-1 Groundwater OU where gradients are very shallow and therefore ambiguous. A three-dimensional map of the rate of aqueous mass transport would be of significant benefit for locating preferential pathways.

A1.6 DATA QUALITY OBJECTIVES

This SAP is based on EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4. The data quality objective (DQO) process is a strategic planning approach for defining the criteria that a data collection design should satisfy. The DQO process is used to ensure that the type, quantity, and quality of environmental data used in decision making is appropriate for the intended application.

This section summarizes the results of SGW-34011, *Data Quality Objectives Summary Report Supporting the 200 PO 1 Groundwater Operable Unit.*

A1.6.1 Statement of the Problem

The purpose of this DQO process is to identify and evaluate the data needs to support the RI/FS process for the 200-PO-1 Groundwater OU. This DQO defines and evaluates the data needs to define the nature and extent of contamination, risk assessment, evaluation of remedial action alternatives, and long-term monitoring of completed remedial actions.

Emphasis is on the development of a list of COPCs in the groundwater of the 200-PO-1 Groundwater OU. The COPC list was developed in two steps. First, existing documents were examined to prepare a comprehensive list of radionuclides and hazardous chemicals disposed of or used in processes at facilities within the 200-PO-1 Groundwater OU, as well as in the neighboring 200-BP-5 Groundwater OU and the BC Cribs and Trenches Area. A total of 339 potential contaminants were discovered.

Second, the *Hanford Environmental Information System* (HEIS) database was queried for the period November 1, 1988, to November 1, 2006, for 189 wells within the 200-PO-1 Groundwater OU. The purpose of the query was to evaluate analytical results for the 339 potential contaminants discovered in the first step, above, and an additional 257 potential contaminants for which analytical data are recorded in HEIS. The query yielded a list of 44 COPCs (Table A1-2) in two categories:

- Groundwater contaminants with concentrations greater than state and/or Federal MCLs
- Potential contaminants for which no analytical data were available, and which, therefore, could not be excluded.

Table A1-2. Contaminants of Potential Concern for the 200-PO-1 Groundwater Operable Unit.

1,1,2,2-Tetrachloroethane	Manganese
1,2-Dichloroethane	Methylene chloride
1,4-Dioxane[b]	Neptunium-237[a]
2,4-Dinitrophenol	Nickel
Antimony	Nitrate
Arsenic	Nitrite
Benzene	Nitrobenzene
Bis(2-ethylhexyl) phthalate	Pentachlorophenol
Bromodichloromethane	Protactinium-231[a]
Cadmium	Selenium-79[a]
Carbon tetrachloride	Strontium-90
Chromium	Technetium-99
Dieldrin	Thallium
Dimethoate	Tritium
Dibromochloromethane	Tetrachloroethylene
Fluoride	Trichloroethylene
Gross alpha[c]	Uranium
Hexane[a]	Uranium-234
Heptachlor	Uranium-238
Heptachlor epoxide	Vanadium
Iodine-129	Vinyl chloride
Lead	Zinc

[a]Constituents never recorded as measured in the 200-PO-1 Groundwater Operable Unit.
[b]Constituents not found in historical process documents, but are found in the 200-PO-1 Groundwater Operable Unit.
[c] Represents a survey parameter.

A1.6.2 Decision Rules

A decision rule (DR) is an "if…then…" statement that incorporates the parameter of interest, the unit of decision making, the action level, and the action(s) that would result from resolution of the decision. The DRs are presented in Table 5-2 of the DQO Summary Report (FH 2007) in tabular form. Several of the Decision Statements require professional judgment to evaluate data from widely differing sources and quality. In some cases, the data for a specific DR are not currently available. As discussed in Section 2.0 of the DQO summary report (SGW-34011), the principal study questions do not necessarily relate to a single sample statistic. In many cases, there is no sample statistic that relates directly to the question that must be answered. As a result of these considerations, the DRs are more complicated than a simple comparison of a single analyte to a specific regulatory action level, or PRG.

A1.6.3 Analytical requirements

Table A1-3 reflects performance requirements for the analytical determination in groundwater of the individual constituents.

Table A1-3. Performance Requirements for Groundwater Analysis. (3 Pages)

Constituent	CAS#	PRG[a]	Analytical Method[a]	Required Quantitation Limit	Precision	Accuracy
Radionuclides (pCi/L)						
Gross alpha[c]	12587-46-1	15	Alpha/beta GPC	3	±30%[d]	70 – 130%[d]
Iodine-129	15046-84-1	1[b]	I-129 liquid stint. (low level)	1		
Neptunium-237	13994-20-2	15	Neptunium-237 - AEA	1		
Protactinium-231	14331-85-2	-- [b]	Protactinium-231 - AEA	1		
Selenium-79	15758-45-9	-- [b]	LSC	30		
Strontium-90	10098-97-2	8	Gas proportional counting	2		
Technetium-99	14133-76-7	900	Tc-99 LSC or GPC	15		
Tritium	10028-17-8	20,000	H-3 LSC (mid-level)	400		
Uranium-234	13966-29-5	20	Isotopic uranium - AEA	1		
Uranium-238	U-238					
Inorganics – Metals (µg/L)						
Antimony	7440-36-0	6[b]	6010 B/200.8	6	±30%[e]	70 – 130%[e]
Arsenic	7440-38-2	10	Trace ICP	6		
Cadmium	7440-43-9	10	6010 B/200.8	2		
Chromium	7440-47-3	100	6010 B/200.8	10		
Lead	7439-92-1	15	6010 B/200.8	5		
Manganese	7439-96-5	2200	6010 B/200.8	5		
Nickel	7440-02-0	320	6010 B/200.8	40		
Thallium	7440-28-0	1.1	Trace ICP	0.5		
Uranium (total)	7440-61-1	30	6020B/200.8/kinetic phosphorescence	0.1		
Vanadium	7440-62-2	110	6010 B/200.8	25		
Zinc	7440-66-6	4800	6010 B/200.8	10		

Table A1-3. Performance Requirements for Groundwater Analysis. (3 Pages)

Constituent	CAS#	PRG[a]	Analytical Method[g]	Required Quantitation Limit	Precision	Accuracy
Inorganics – Nonmetals (µg/L)						
Fluoride	16984-48-8	960	Anions by IC – 300.0	500	±30%[e]	70 – 130%[e]
Nitrate as NO_3	14797-55-8	44,300	Anions by IC – 300.0	75		
Nitrite as NO_2	14797-65-0	3,290	Anions by IC – 300.0	75		
Volatile Organics (µg/L)						
1,1,2,2-Tetrachloroethane	79-34-5	0.22[b]	Volatile organics – 8260 B	5	±30%[f]	50 – 150%[f]
1,2-Dichloroethane	107-06-2	0.48[b]	Volatile organics – 8260 B	1.5		
Benzene	71-43-2	0.8[b]	Volatile organics – 8260 B	1.5		
Bromodichloromethane	75-27-4	0.71[b]	Volatile organics – 8260 B	5		
Carbon tetrachloride	56-23-5	0.34[b]	Volatile organics – 8260 B	1.5		
Dibromochloromethane	124-48-1	0.52[b]	Volatile organics – 8260 B	5		
Hexane	110-54-3	480	Volatile organics – 8260 B	5		
Methylene chloride	75-09-2	5[b]	Volatile organics – 8260 B	5		
Tetrachloroethylene	127-18-4	0.081[b]	Volatile organics – 8260 B	1		
Trichloroethylene (TCE)	79-01-6	0.11[b]	Volatile organics – 8260 B	2		
Vinyl chloride	75-01-4	0.029[b]	Volatile organics – 8260 B	5		
Semivolatile Organics (µg/L)						
1,4-Dioxane	123-91-1	4[b]	Semivolatile organics–8270 C	10		
2,4-Dinitrophenol	51-28-5	32	Semivolatile organics–8270 C	25	±30%[f]	50 – 150%[f]
Bis (2-ethylhexyl) phthalate	117-81-7	6[b]	Semivolatile organics–8270 C	10		
Nitrobenzene	98-95-3	4[b]	Semivolatile organics–8270 C	10	±30%[f]	50 – 150%[f]
Pentachlorophenol	87-86-5	0.73[b]	Semivolatile organics–8270 C	10		
Pesticides (µg/L)						
Dieldrin	60-57-1	0.0055[b]	Pesticides – 8081 B	0.1	±30%	50 – 150%
Dimethoate	60-51-5	3.2[b]	Semivolatile – 8270 C	20		
Heptachlor	76-44-8	0.019[b]	Pesticides – 8081 B	0.05		
Heptachlor epoxide	1024-57-3	0.0048[b]	Pesticides – 8081 B	0.05		

[a] The PRG is the lowest of the MCL and WAC 173-340, "Model Toxics Control Act -- Cleanup," limits, except when background is higher, and then background is selected.
[b] These values have the RQL>PRG, or the RQL is equal to the PRG. When this occurs the RQL will become the PRG, based on WAC 173-340-707, "Analytical Considerations."
[c] Represents a survey parameter to be used.
[d] Accuracy criteria for associated batch laboratory control sample percent recoveries for radionuclides. With the exception of GEA, additional analysis-specific evaluations also performed for matrix spikes, tracers, and carriers, as appropriate to the method. Precision criteria for batch laboratory replicate sample analyses.
[e] Accuracy criteria for associated batch matrix spike percent recoveries for inorganics. Evaluation based on statistical control of laboratory control samples also performed. Precision criteria for batch laboratory replicate matrix spike sample analyses or replicate sample analyses.
[f] Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries for organics. Laboratories must meet statistically based control if more stringent. Additional analyte-specific evaluations also performed for matrix spikes and surrogates as appropriate to the method. Precision criteria for batch laboratory replicate matrix spike sample analyses.
[g] Four-digit EPA Methods are found in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-B*, as amended; EPA Method 200.8, is found in EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*; EPA Method 300.0 is found in EPA/600/4-79/020, *Methods of Chemical Analysis of Water and Wastes*.

AEA = alpha energy analysis.
CAS = Chemical Abstracts Service.
EPA = U.S. Environmental Protection Agency.
GEA = gamma energy analysis.
GPC = gas proportional counting.
IC = ion chromatography.
ICP = inductively coupled plasma.
LSC = liquid scintillation counting.
MCL = maximum contaminant level.
PRG = preliminary remediation goal.
RQL = required quantitation limit.
VOA = volatile organic analysis.

Table A1-3. Performance Requirements for Groundwater Analysis. (3 Pages)

Constituent	CAS#	PRG[a]	Analytical Method[g]	Required Quantitation Limit	Precision	Accuracy
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Benzene	71-43-2	0.8[b]	Volatile organics – 8260 B	1.5		
Bromodichloromethane	75-27-4	0.71[b]	Volatile organics – 8260 B	5		
Carbon tetrachloride	56-23-5	0.34[b]	Volatile organics – 8260 B	1.5		
Dibromochloromethane	124-48-1	0.52[b]	Volatile organics – 8260 B	5		
Hexane	110-54-3	480	Volatile organics – 8260 B	5		
Methylene chloride	75-09-2	5[b]	Volatile organics – 8260 B	5		
Tetrachloroethylene	127-18-4	0.081[b]	Volatile organics – 8260 B	1		
Trichloroethylene (TCE)	79-01-6	0.11[b]	Volatile organics – 8260 B	2		
Vinyl chloride	75-01-4	0.029[b]	Volatile organics – 8260 B	5		
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Constituent	CAS#	PRG[a]	Analytical Method[a]	Required Quantitation Limit	Precision	Accuracy
			Radionuclides (pCi/L)			
Gross alpha[c]	12587-46-1	15	Alpha/beta GPC	3	±30%[d]	70 – 130%[d]
Iodine-129	15046-84-1	1[b]	I-129 liquid stint. (low level)	1		
Neptunium-237	13994-20-2	15	Neptunium-237 - AEA	1		
Protactinium-231	14331-85-2	--[b]	Protactinium-231 - AEA	1		
Selenium-79	15758-45-9	--[b]	LSC	30		
Strontium-90	10098-97-2	8	Gas proportional counting	2		
Technetium-99	14133-76-7	900	Tc-99 LSC or GPC	15		
Tritium	10028-17-8	20,000	H-3 LSC (mid-level)	400		
Uranium-234	13966-29-5	20	Isotopic uranium - AEA	1		
Uranium-238	U-238					
			Inorganics – Metals (µg/L)			
Antimony	7440-36-0	6[b]	6010 B/200.8	6	±30%[c]	70 – 130%[c]
Arsenic	7440-38-2	10	Trace ICP	6		
Cadmium	7440-43-9	10	6010 B/200.8	2		
Chromium	7440-47-3	100	6010 B/200.8	10		
Lead	7439-92-1	15	6010 B/200.8	5		
Manganese	7439-96-5	2200	6010 B/200.8	5		
Nickel	7440-02-0	320	6010 B/200.8	40		
Thallium	7440-28-0	1.1	Trace ICP	0.5		
Uranium (total)	7440-61-1	30	6020B/200.8/kinetic phosphorescence	0.1		
Vanadium	7440-62-2	110	6010 B/200.8	25		
Zinc	7440-66-6	4800	6010 B/200.8	10		

A2.0 QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

- DOE O 414.1C, *Quality Assurance*
- 10 CFR 830.121
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5.

The following sections describe the quality requirements and controls applicable to this investigation. Note that the QAPjP of the routine SAP presented in Appendix B will not have the exact same requirements (the routine SAP [Appendix B] is a preapproved document published in 2005). Correlation between EPA QA/R-5 requirements and information in this chapter is provided in Table A2-1.

Table A2-1. Correlation Between EPA QA/R-5 Requirements and the Sampling and Analysis Plan (EPA/240/B-01/003).

EPA QA/R-5 Criteria	EPA QA/R-5 Title	Reference Section
Project Management	Project/Task Organization	A2.1.1
	Problem Definition/Background	A1.0
	Project/Task Description	A2.2
	Quality Objectives and Criteria	A2.3
	Special Training/Certification	A2.4
	Documents and Records	A2.5
Data Generation and Acquisition	Sampling Process Design	A1.5, A3.5
	Sampling Methods	A2.6, A3.3.2, A3.5
	Sample Handling and Custody	A2.6.3, A2.6.4, A2.6.5
	Analytical Methods	A2.6.6, Table A1-3
	Quality Control	A2.6.7, A2.6.7.1, A2.6.7.2, A2.6.7.3
	Instrument/Equipment Testing, Inspection, and Maintenance	A2.6.8
	Instrument/Equipment Calibration and Frequency	A2.6.9
	Inspection/Acceptance of Supplies and Consumables	A2.6.10
	Non-direct Measurements	A2.6.11
	Data Management	A2.6.12
Assessment and Oversight	Assessments and Response Actions	A2.7.1
	Reports to Management	A2.7.2
Data Validation and Usability	Data Review, Verification, and Validation	A2.8
	Verification and Validation Methods	A2.8.2, A2.8.3
	Reconciliation with User Requirements	A2.8.3

EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5

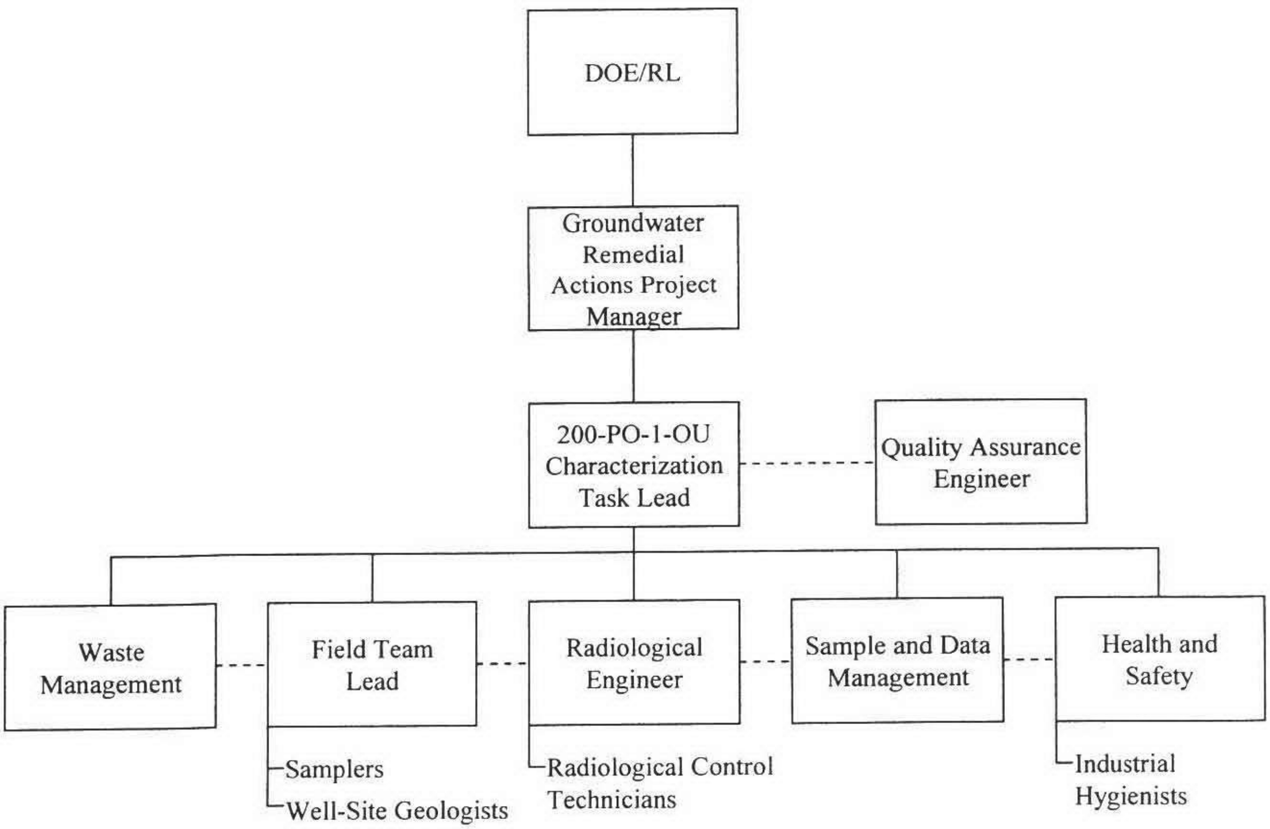
Quality assurance (QA) requirements are implemented according to the internal Fluor Hanford, Inc. (FH) QA Program. The QA Program describes how FH implements the QA requirements conveyed in DOE O 414.1C and 10 CFR 830.121, "Quality Assurance Program (QAP)," and how the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989, as amended) and Hanford Site internal laboratory QA requirements apply to FH environmental QA program plans.

All work performed under this SAP will be performed in compliance with the FH QA Program plan, the FH Groundwater Remediation Project plan, or subsequent and equivalent FH quality program plans. Field sample collection and documentation activities will be performed according to applicable FH procedures, except as modified for certain nonroutine procedures documented herein.

A2.1 PROJECT ORGANIZATION

The project organization is described in the subsections that follow and is shown in Figure A2-1.

Figure A2-1. Project Task Organization.



200-PO-1 OU = 200-PO-1 groundwater Operable Unit.
DOE/RL = U.S. Department of Energy, Richland Operations Office.

A2.1.1 Project Task Organization

The goal of the project is to collect data to support an RI/FS for 200-PO-1 Groundwater OU. FH, or its approved subcontractor, is responsible for collecting, packaging, and shipping samples to the laboratory. FH will select a laboratory to perform the analyses; the selected laboratory must conform to Hanford Site laboratory procedures (or equivalent), as approved by the U.S. Department of Energy (DOE), Richland Operations Office (RL); the EPA; and the Washington State Department of Ecology (Ecology). FH is responsible for managing all interfaces among subcontractors involved in executing the work described in this SAP. The project organization is described in the subsections that follow and is shown in Figure A2-1.

A2.1.2 Groundwater Remedial Actions Project Manager

The Groundwater Remedial Actions Project Manager provides oversight for all activities and coordinates with RL and the regulators in support of sampling activities. In addition, support is provided to the 200-PO-1 Groundwater OU Characterization Task Lead to ensure that the work is performed safely and cost-effectively.

A2.1.3 200-PO-1 Groundwater Operable Unit Characterization Task Lead

The 200-PO-1 Groundwater OU Characterization Task Lead is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The 200-PO-1 Groundwater OU Characterization Task Lead ensures that the Field Team Leader, samplers, and others responsible for implementation of this SAP are provided with current copies of this document and any revisions thereto. The 200-PO-1 Groundwater OU Characterization Task Lead works closely with QA, health and safety, and the Field Team Leaders and the other discipline leads to form an integrated team for the planning and implementation of the work. The 200-PO-1 Groundwater OU Characterization Task Lead also coordinates with, and reports to, RL, the regulators, and the Hanford Management Contractor on all sampling activities.

A2.1.4 Quality Assurance Engineer

The Quality Assurance Engineer coordinates directly with the 200-PO-1 Groundwater OU Characterization Task Lead and is responsible for QA issues on the project. Responsibilities include oversight of implementation of the project QA requirements; review of project documents, including SAPs (and the QAPjP); and participation in QA assessments on sample collection and analysis activities, as appropriate.

A2.1.5 Waste Management

The Waste Management Lead communicates policies and procedures and ensures project compliance for safe and effective storage, transportation, disposal, and tracking of waste.

Other responsibilities include identifying waste management sampling/characterization requirements to ensure regulatory compliance interpretation with WAC 173-303, "Dangerous Waste Regulations," and the applicable waste control plan.

A2.1.6 Field Team Leader

The Field Team Leader has the overall responsibility for the planning, coordination, and execution of the field characterization activities. Specific responsibilities include converting the sampling design requirements into field task instructions that provide specific direction for field activities. Responsibilities also include directing training and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The Field Team Leader communicates with the 200-PO-1 Groundwater OU Characterization Task Lead to identify field constraints that could affect the sampling design. In addition, the Field Team Leader directs the procurement and installation of materials and equipment needed to support the field work.

The Field Team Leader oversees field-sampling activities that include sample collection, packaging, provision of certified clean sampling bottles/containers, and documentation of sampling activities in controlled logbooks, chain-of-custody documentation, and packaging and transportation of samples to the laboratory or shipping center.

The Field Team Leader, field geologists, samplers, and others responsible for implementation of this SAP and the QAPjP will be provided with current copies of this document and any revisions that follow.

A2.1.7 Radiological Engineering

The Radiological Engineering Lead is responsible for the radiological engineering and health physics support within the project. Specific responsibilities include conducting as-low-as-reasonably-achievable reviews, exposure and release modeling, and optimizing radiological controls for all planned work. In addition, radiological hazards are identified and appropriate controls are implemented to minimize worker exposure to radiologic hazards. Radiological Engineering interfaces with the project safety and health representative and plans and directs radiological control technician support for all activities.

A2.1.8 Sample and Data Management

The Sample and Data Management organization selects the laboratories that perform the analyses. This organization also ensures that the laboratories conform to Hanford Site internal laboratory QA requirements, or their equivalent, as approved by RL, the EPA, and Ecology. The Sample and Data Management organization initiates audits of the laboratories periodically to ensure compliance. Sample and Data Management receives the analytical data from the laboratories, makes the data entry into the HEIS database, and arranges for data validation. Validation will be performed on completed data packages (including quality control [QC] samples) by FH's Environmental Information Services group or by a qualified independent contractor.

A2.1.9 Health and Safety

Responsibilities include coordination of industrial safety and health support within the project as carried out through safety and health plans, job hazard analyses, and other pertinent safety documents required by Federal regulation or by internal FH work requirements. In addition, assistance is provided to project personnel in complying with applicable health and safety standards and requirements. Personal protective clothing requirements are coordinated with Radiological Engineering.

A2.2 PROJECT/TASK DESCRIPTION

Sampling and analysis activities will be performed to characterize groundwater samples that are collected during borehole drilling in the 200-PO-1 Groundwater OU. Geophysical logs will be prepared for each borehole. Aquifer tubes will be installed along the river corridor to sample near-shore sediment pore water. The sampling and analysis activities are described in further detail in Chapter A3.0. A statement of work will be written for each geophysical measurement process. The statement of work will specify that each company will have a specific QA/QC program based on SEG Y (SEG, 2002, *SEG Y Data Exchange Format*) or equivalent standards.

A2.3 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Laboratory analytical detection limits and the precision and accuracy requirements for each laboratory analysis to be performed are summarized Section A1.6.1. Performance criteria are presented in Table A1-3.

A2.4 SPECIAL TRAINING REQUIREMENTS AND CERTIFICATIONS

Training or certification requirements for sampling personnel will be in accordance with the requirements specified in the Hanford Site internal laboratory QA requirements. Training records are recorded by individuals in an electronic training record database, and the contractor training organization maintains the records system, Line management will be used to confirm that an individual employee's training is appropriate and up-to-date before performing any field work.

Field personnel typically will have completed the following training before starting work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training
- 8-Hour Hazardous Waste Worker Refresher Training (as required)

- Radiological Worker II Training
- Hanford General Employee Training.

A2.5 DOCUMENTATION AND RECORDS

The 200-PO-1 Groundwater OU Characterization Task Lead is responsible for ensuring that the Field Team Leader, samplers, and others responsible for implementation of this SAP are provided with current copies of this document and any revisions that follow. The Groundwater Remedial Actions Project Manager is responsible for ensuring that the project files are properly maintained and stored.

Field sampling and well-site activity documentation will be performed in accordance with FH procedures pertaining to the following:

- Notebooks and logbooks
- Geologic logging
- Groundwater sampling
- Calibration of field equipment
- Sampling documentation
- Chain-of-custody/sample analysis requests
- Sample packaging and shipping.

Laboratory analytical documentation will be in accordance with the current statement of work for environmental and waste characterization analytical services groundwater sampling and analysis. Overall project documentation will be in accordance with the FH procedures standards-based management system.

Data and information generated from the sampling activities will be used to support 200-PO-1 Groundwater OU characterization. The data and information will be incorporated into project documents including a borehole summary report and final project report.

A2.6 DATA AND MEASUREMENT ACQUISITION

The following subsections present the requirements for sampling methods, sample handling and custody, analytical methods, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management also are addressed.

A2.6.1 Sampling Methods Requirements

The borehole and groundwater sampling associated with this SAP will be performed in accordance with established sampling practices and requirements pertaining to sample collection, equipment collection, and sample handling. The Field Team Leader and the 200-PO-1 Groundwater OU Characterization Task Lead are responsible for ensuring that all field procedures are followed completely and that field personnel are trained adequately. The Field

Team Leader and the 200-PO-1 Groundwater OU Characterization Task Lead must document situations that may impair the usability of the samples and/or data in the field logbook or on nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The Field Team Leader will note any deviations from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring that occurs. The Field Team Leader also will be responsible for coordinating all activities relating to the use of field monitoring equipment (e.g., dosimeters and industrial hygiene equipment). Field personnel will document in the logbook all noncompliant measurements taken during field sampling. Ultimately, the 200-PO-1 Groundwater OU Characterization Task Lead, or the Field Team Leader (at the discretion of the 200-PO-1 Groundwater OU Characterization Task Lead), will be responsible for communicating field corrective-action procedures, for documenting all deviations from procedure, and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact the quality of data or impair the ability to acquire data, or failure to follow procedure, will be documented in accordance with internal corrective action procedures, as appropriate.

Sample preservation, containers, and holding times for chemical and radiological analytes of interest and physical property analysis are presented in Table A2-2. Final sample collection requirements will be identified on the Sampling Authorization Form.

Table A2-2. Sample Preservation Requirements and Holding Times.

Analytes	Container		Volume	Preservation	Packing Requirements	Holding Time
	Number	Type				
Volatile organics	2	Glass vial, no headspace	(4) 40 mL	pH<2 with HCl	Cool 4°C	14 days
Gross alpha/beta	1	Plastic	1 L	None	None	N/A
AEA (Np-237, Po-231, U-234, U-238)	1	Plastic	1 L	None	None	N/A
GPC (Sr-90)	1	Plastic	2 L	None	None	N/A
Tc-99	1	Plastic	1 L	None	None	N/A
Metals	1	Plastic	500 mL	pH<2 with HNO_3	None	<180 days
Semivolatile organics	2	Glass amber	2 L	None	Cool 4°C	7 days collect to preparation 40 day prep to analysis
Pesticides	2	Glass amber	2 L	None	Cool 4°C	7 days collect to preparation 40 day prep to analysis
H-3	1	Plastic	120 mL	None	None	N/A
I-129	1	Plastic	8 L	None	None	N/A
Anions (fluoride)	1	Plastic	500 mL	None	Cool 4°C	28 days
Anions (nitrate, nitrite)	1	Plastic	500 mL	None	Cool 4°C	48 hours [b]

AEA = alpha energy analysis. GPC = gas-proportional counting. N/A = not applicable.

Additional details on sampling methods are provided in Chapter A3.0.

A2.6.2 Sample Identification

The *Sample Data Tracking* database will be used to track the samples from the point of collection through the laboratory analysis process. The HEIS database is the repository for laboratory analytical results. The HEIS database sample numbers will be issued to the sampling organization for this project. The HEIS database numbers are to be carried through the laboratory data-tracking system.

A2.6.3 Sample Handling, Shipment, Decontamination, and Custody

All sample handling, labeling, shipping, and custody requirements will be performed in accordance with applicable FH procedures pertaining to sample packaging and shipping and chain of custody/sample analysis requests. Either sample containers will be purchased as precleaned by vendors who supply bottles that meet EPA bottle-cleaning protocols, or the bottles will be supplied by the laboratory. Level I EPA precleaned sample containers will be used for samples collected for chemical and radiological analysis. The laboratories under contract to FH have been audited to the EPA requirements governing bottle preparation, addition of appropriate preservatives, and bottle supply preparation.

A2.6.4 Sample Preservation, Containers, and Holding Times

Sample preservation, container, and holding time requirements will be prepared for specific sample events as specified on the Sampling Authorization Forms and Chain-of-Custody Forms in accordance with the FH procedures and the specific analytical methods. Sample preservation requirements, containers to be used, and holding times are presented in Table A2-2.

A2.6.5 Analytical Methods Requirement

Analytical parameters, procedures, and methods are addressed in Section A1.6.1. Laboratory-specific standard operating procedures for analytical methods are described in the Hanford Site internal laboratory QA requirements.

Errors by the laboratories are reported to the Sample Management Project Coordinator, who initiates a Sample Disposition Record in accordance with FH procedures. This process is used to document analytical errors and to establish resolution with the 200-PO-1 Groundwater OU Characterization Task Lead.

Errors or difficulties encountered during field analysis will be reported to the Horn Investigation Task Lead.

A2.6.6 Quality Control Requirement

The QC procedures described in the Hanford Site internal laboratory QA requirements must be followed in the field and laboratory to ensure that reliable data are obtained. When this field sampling is performed, care should be taken to prevent the cross contamination of sampling equipment, sample bottles, and other equipment that could compromise sample integrity.

Table A2-3 lists the field QC requirements for sampling. If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. If no volatile organic compound samples are collected, then a field transfer blank is not required.

Table A2-3. Field Quality Control Requirements.

Sample Type	Frequency	Purpose
Duplicate	5% (1 sample in 20)	To check the precision of the laboratory analyses
Equipment rinsate	One per 10 well trips	To check the effectiveness of the decontamination process
Field transfer blank	One per day when volatile organics are sampled	To check for contamination during transport

Field transfer blanks are not required when simply transferring samples to the field gas chromatograph for analysis.

The laboratory method blanks, laboratory control sample/blank spike, and matrix spike are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-B*, as amended, and will be run at the frequency specified in that reference.

Quality objectives and criteria (including analytical methods, detection limits, and precision and accuracy requirements for each analysis to be performed) are summarized in Table A1-3.

The QA objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is assessed by accuracy and precision, by evaluation against the identified DQOs, and by evaluation against the work activities identified in this SAP. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method, which are addressed in the following subsections.

A2.6.6.1 Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. Accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. A matrix spike is the addition to a sample of a known amount of a standard compound similar to the compounds being measured. Radionuclide measurements that require chemical separations use this technique to measure method performance. For radionuclide measurements that are analyzed by gamma spectroscopy, laboratories typically compare the results of blind audit samples against known standards to establish accuracy. Validity of calibrations is evaluated by comparing results from the measurement of a standard to known values and/or by generating in-house statistical limits based on three standard deviations (*i.e.*, ±3 SD). Table A1-3 lists the accuracy requirements for fixed laboratory analyses for the project.

A2.6.6.2 Precision

Precision is a measure of the data spread when more than one measurement has been taken on the same sample. Precision can be expressed as the relative percent difference for duplicate measurements. Analytical precision requirements for fixed laboratory analyses are listed in Table A1-3.

A2.6.6.3 Detection Limits

Detection limits are functions of the analytical method used to provide the data and the quantity of the sample available for analyses. Detection limits identified for analyses for this project are listed in Table A1-3.

A2.6.7 Instrument/Equipment Testing, Inspection, and Maintenance

All onsite environmental instruments will be tested, inspected, and maintained in accordance with manufacturer's specifications and FH procedures pertaining to control and calibration of field and monitoring instruments. The results from all testing, inspection, and maintenance activities will be recorded in a bound logbook in accordance with applicable FH procedures.

Calibration of laboratory instruments and equipment will be performed in a manner consistent with SW-846 or with auditable DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed per SW-846 requirements and will be appropriate for their use.

A2.6.8 Instrument Calibrations and Frequency

Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratories' QA plan. All onsite environmental instruments will be calibrated in accordance with manufacturer's specifications and FH procedures pertaining to the following:

- Calibration requirements of field measurement equipment
- Control of monitoring instruments.

Calibrations will be documented and traceable to standards that have a known valid relationship to nationally recognized standards or to reputable vendors or standards required by the regulatory agencies. The results from all testing, inspection, and maintenance activities will be recorded in a bound logbook in accordance with applicable FH procedures. Tags will be attached to all field screening and onsite analytical instruments, noting the date when the instrument was last calibrated and the calibration expiration date.

A2.6.9 Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables procured by FH that are used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the FH acquisition system and the responsibilities and interfaces necessary to ensure that structures, systems, and components, or other items and services procured/acquired for FH meet the specific technical and quality requirements. The procurement process ensures that purchased items and services comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users before use.

Supplies and consumables procured by the analytical laboratories are checked and used in accordance with the laboratories' QA plans.

A2.6.10 Nondirect Measurement

Nondirect measurement sources such as computer data bases, programs, and literature files were used during preparation of the DQO summary report (SGW-34011) to assist with well-placement decisions and determination of COPCs.

A2.6.11 Data Management

Data resulting from the implementation of this QAPjP will be managed and stored in accordance with applicable programmatic requirements governing data management procedures. At the direction of the 200-PO-1 Groundwater OU Characterization Task Lead, all analytical data packages will be subject to final technical review by qualified personnel before the results are submitted to the regulatory agencies or before they are included in reports. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement (Ecology et al., 1989).

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed laboratory sample collection activities, as discussed in the sampling procedures. In the event that specific procedures do not exist for a particular task, or if additional guidance to complete certain tasks is needed, a work package will be developed to adequately control the activities. Examples of the sample teams' requirements include the activities associated with the following:

- Chain of custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks, checklists
- Sample packaging and shipping.

Approved work control packages and procedures will be used to document radiological measurements when implementing this SAP. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information as per 10 CFR 835, "Occupational Radiation Protection"
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of Hanford Site radiological records
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related records
- The indoctrination of personnel on the development and implementation of survey/sample plans
- The requirements associated with preparing and transporting regulated material.

Data will be cross referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

A2.7 ASSESSMENT AND OVERSIGHT

A2.7.1 Assessments and Response Actions

The FH Compliance and Quality Programs group may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. No specific assessments are planned for this investigation.

Deficiencies identified during these assessments will be reported in accordance with existing programmatic requirements. The Central Plateau QA Group coordinates the corrective actions/deficiencies in accordance with FH's QA Program. When appropriate, corrective actions will be taken by the Project Engineer and/or 200-PO-1 Groundwater OU Characterization Task Lead.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. FH conducts oversight of offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

A2.7.2 Reports to Management

Management will be made aware of all deficiencies identified by self-assessments. Identified deficiencies will be reported to the 200-PO-1 Groundwater OU Characterization Task Lead.

A2.8 DATA REVIEW, VERIFICATION, VALIDATION, AND USABILITY REQUIREMENTS FOR CHARACTERIZATION DATA

There are two objectives for sampling in 200-PO-1 Groundwater OU. One is characterization and the second is monitoring. When initial characterization or the first round of groundwater sampling is performed, the data review, verification and validation are performed as discussed in the remainder of Section A2.8. Section A2.9 presents the approach for data review, verification, and validation for monitoring data after the first round is completed.

A2.8.1 Data Verification and Usability Methods

Data review and verification are performed by the laboratory to confirm that sampling and chain-of-custody documentation are complete. This review will include tying laboratory sample numbers to project sample numbers, reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times have been met, and reviewing QC data to determine whether analyses met the data quality requirements.

All data verification and usability assessments will be performed in accordance with the Hanford Site internal laboratory QA requirements.

For field data, verification and usability assessment will be performed using FH internal requirements.

A2.8.2 Data Validation

Completed data packages will be validated by qualified FH Sample and Data Management personnel or by a qualified independent contractor. Validation will consist of verifying required deliverables, comparing requested versus reported analyses, and identifying transcription errors. Validation also will include evaluating and qualifying the results based on holding times, method blanks, laboratory control samples, laboratory duplicates, and chemical and tracer recoveries, as appropriate. No other validation or calculation checks will be performed.

Level C data validation, as defined in the contractor's validation procedures (which are based on the EPA's functional guidelines [Bleyler, 1988a, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*; Bleyler, 1988b, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*]), will be performed for up to 5 percent of the data by matrix and analyte group. The goal is to cover the various analyte groups and matrices during the validation. When outliers or illogical results are identified in the data quality assessment, additional data validation will be performed. The additional validation will be up to 5 percent of the statistical outliers and/or illogical data. The additional validation will begin with Level C and may increase to Levels D and E as needed to ensure that the data are usable. Note that Level C validation is a review of the QC data, while Levels D and E include review of calibration data and calculations of representative samples from the data set. All data validation will be documented in data validation reports. With the exception of "R" qualified or rejected data, all data will be used.

At least one data validation package will be generated. The validation requirements identified in this section are consistent with Level C validation, as defined in data validation procedures. Relative to analytical data, physical data and/or field screening results are of lesser importance in making inferences of risk. Because of the secondary importance of such data, no validation for physical property data and/or field screening results will be performed; however, field QA/QC will be reviewed to ensure that the data are useable. Field instrumentation, calibration, and QA checks will be performed in accordance with the following.

- •Calibration of radiological field instruments on the Hanford Site is performed under contract by Pacific Northwest National Laboratory, as specified in their program documentation.
- •Daily calibration checks will be performed and documented for each instrument used, to characterize areas that are under investigation. These checks will be made on standard materials that are sufficiently like the matrix under consideration so direct comparison of data can be made. Analysis times will be sufficient to establish detection efficiency and resolution.

The approval of field-data collection plans by the Radiological Engineering Manager represents the data validation and usability review for hand-held field radiological measurements

A2.8.3 Data Quality Assessment

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. The EPA data quality assessment process, EPA/240/B-06/002, *Data Quality Assessment: A Reviewers Guide*, EPA QA/G-9R, identifies five steps for evaluating data generated from this project, as summarized below.

Step 1. Review DQOs and Sampling Design. This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO workbook and SAP.

Step 2. Conduct a Preliminary Data Review. In this step, a comparison is made between the actual QA/QC achieved (e.g., detection limits, precision, accuracy) and the requirements determined during the DQO. Any significant deviations will be documented. Basic statistics will be calculated from the analytical data at this point, as appropriate to the data set, including an evaluation of the distribution of the data and in accordance with the DQOs.

Step 3. Select the Statistical Test. Using the data evaluated in Step 2, an appropriate statistical hypothesis test is selected and justified.

Step 4. Verify the Assumptions. In this step, the validity of the data analyses is assessed by determining if the data support the underlying assumptions necessary for the analyses or if the data set must be modified (e.g., transposed, augmented with additional data) before further analysis. If one or more assumptions are questioned, Step 3 is repeated.

Step 5. Draw Conclusions from the Data. The statistical test is applied in this step, and the results either reject the null hypothesis or fail to reject the null hypothesis. If the latter is true, the data should be analyzed further. If the null hypothesis is rejected, the overall performance of the sampling design should be evaluated by performing a statistical power calculation to assess the adequacy of the sampling design.

A2.9 DATA REVIEW, VERIFICATION, VALIDATION, AND USABILITY REQUIREMENTS FOR MONITORING DATA

Monitoring data is a result of repeated sampling of the groundwater in the same well(s). Therefore, trend analysis becomes an important part of reviewing and assessing whether the data are consistent with any pertinent existing plume data. Beginning with the second round of samples from the groundwater, the monitoring data review, verification, and validation process will be used as outlined in Appendix B, Chapters 3.0 and 4.0. Rather than repeat these chapters, the reader is referred to the previously approved monitoring SAP (DOE/RL-2003-04) (Appendix B) provided electronically on compact disk.

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A3.0 FIELD SAMPLING AND MEASUREMENT PLAN

The field sampling and measurement plan defines the number and types of samples to be collected; criteria that apply to sample collection; purpose, analysis, and disposition of each sample type; and the frequency of sample collection. In addition, it briefly addresses field measurements for geophysical and hydrogeologic investigation. The plan separately considers activities based on whether they are applied during or subsequent to well construction, completion, and development. Aquifer tubes also are considered separately.

In addition to the evaluation of COPCs presented, the well selection for sampling and analysis to support the RI/FS includes the activities discussed in Sections 4.3.1 through 4.3.3 of the Work Plan.

A3.1 TWO-PHASED APPROACH

A two-phased approach is planned to complete remedial investigation activities for the 200-PO-1 Groundwater OU (Table A3-1). This is to be incorporated with any geophysical and geotechnical information that has already been established (Sections 4.3.2 and 4.3.3 of the Work Plan).

According to EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, OSWER 9355.3-01, the remedial investigation process serves as a mechanism for collecting data to characterize site conditions; determine the nature of the waste; and assess risk to human health and the environment. The feasibility study continues to serve as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. Data collected in the remedial investigation influence the development of remedial alternatives in the feasibility study. The various phases of the RI/FS process provide an iterative approach to data collection. Two concepts are essential to the phased RI/FS approach.

First, data should generally be collected in several stages, with initial data collection usually limited to developing a general understanding of the site. Field sampling should be phased, so that the results of the initial sampling efforts can be used to refine plans developed during scoping to better focus subsequent sampling. As a basic understanding of site characteristics is achieved, subsequent data collection focuses on filling identified gaps in the understanding of site characteristics and gathering information necessary to evaluate remedial alternatives.

Second, this phased sampling approach encourages identification of key data needs as early in the process as possible to ensure that data collection always is directed toward providing information relevant to selection of a remedial action. In this way the overall site characterization effort can be continually scoped to minimize the collection of unnecessary data and maximize data quality.

Table A3-1. Summary of Phase I and II Characterization Activities.

<table>
<tr><td>Characterization Activities</td><td colspan="2">All wells and frequencies shown in Tables A3-1 and A3-2 of Appendix A</td></tr>
<tr><td>Routine Monitoring Activities</td><td colspan="2">All Wells and frequencies shown in Tables 2-1 and 2-2 of Appendix B</td></tr>
<tr><td colspan="3">Phase I</td></tr>
<tr><td rowspan="7">Opportunistic Wells[b]</td><td>Area</td><td>Well ID[a]</td></tr>
<tr><td rowspan="3">PUREX</td><td>A-2</td></tr>
<tr><td>A-5</td></tr>
<tr><td>A-30</td></tr>
<tr><td rowspan="3">BC Cribs</td><td>A</td></tr>
<tr><td>C</td></tr>
<tr><td>E</td></tr>
<tr><td>Planned Aquifer Tubes</td><td>River Corridor</td><td>10 Sets of 3</td></tr>
<tr><td colspan="3">Phase II</td></tr>
<tr><td rowspan="2">Opportunistic Wells[b]</td><td>Area</td><td>Well ID[a]</td></tr>
<tr><td>PUREX</td><td>A-7</td></tr>
<tr><td rowspan="4">Planned Wells[c]</td><td rowspan="4">To Be Decided</td><td>A</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td></tr>
<tr><td>D</td></tr>
</table>

[a] Preliminary well identification is presented. Once wells are physically established, formal well names will be given.
[b] Opportunistic wells are wells that operable units outside of the 200-PO-1 Groundwater Operable Unit are proposing to drill. These offer an opportunity for supplemental data gathering.
[c] Planned wells are those that may be drilled in the 200-PO-1 Groundwater Operable Unit, but the locations will depend on the data evaluation from Phase I.

A3.2 WELL AND ANALYTE SELECTION FOR PHASE I AND II CHARACTERIZATION AND ASSESSMENT IN THE 200-PO-1 GROUNDWATER OPERABLE UNIT

Sections A3.2.2.1 through A3.2.3 explain details of the summary information that is provided in the following paragraphs. A total of 107 wells are selected for assessment in the 200-PO-1 Groundwater OU. It is proposed that 10 aquifer tubes be drilled in Phase I along the river corridor. An aquifer tube consists of a set of three tubes emplaced at different depths vertically in one well casing. Each tube will be sampled for the 44 COPCs listed in Table A1-2. In addition, six wells, three from the PUREX Area (A-2, A-5, and A-30) and three from the BC Crib and Trenches Area (A, C, and E) will be opportunistically sampled in Phase I. One well (A-7) proposed for drilling in fiscal year 2009 adjacent to the 216-A-7 Crib also will be opportunistically sampled in Phase II. Opportunistic wells are wells that are being drilled in other OUs, including waste sites where the 200-PO-1 Groundwater OU Characterization Task Lead will collect samples to acquire supplemental data. Four wells (A, B, C, and D) will be installed in the 200-PO-1 Groundwater OU during Phase II. The specific locations of these 4 new wells are to be determined through the Phase I data collection. The remaining 86 wells are existing wells that are to be added for assessment with the analytes and frequency of sampling shown in Tables A3-2 and A3-3.

The analytes chosen in Phase I and II for analyses comprise two categories: routine monitoring analytes, and a list of 44 analytes. The routine monitoring analytes are constituents that are routinely monitored within the 200-PO-1 Groundwater OU and can be found in Tables B2-1 and B2-2 of Appendix B. The list of 44 analytes presented in Table A1-2 consists of constituents that were designated as COPCs from the evaluation process presented in the above sections.

A3.2.1 Phase I Near-Field Tasks

Characterization of the 200-PO-1 Groundwater OU will be conducted in two phases. Table A3-1 presents the characterization and routine summaries of Phase I and II activities. The primary objectives for Phase I are to collect data on groundwater contaminants, acquire geophysical data to estimate vertical and lateral extent of contamination, and refine or confirm preferred contaminant pathways. In addition, a detailed evaluation of existing monitoring data will be conducted to assess data needs to determine preliminary fate and transport of analytes in the 200-PO-1 Groundwater OU.

Groundwater and geophysical data will be acquired during Phase I. Data will be gathered to provide information on depth of contaminants in the aquifer, provide information on stratigraphy, define the extent of chromium plume, assess flow direction and hole deviations, and determine depth to water measurements. In Phase I the use of existing transducer equipment in a few chosen near-field wells also will be considered.

Groundwater grab samples will be collected from seven new opportunistic waste site borings in the 200-PO-1 Groundwater OU that intercept the water table. Opportunistic wells allow integration with other OUs. Samples will be collected from boreholes and analyzed for the 44 COPCs that are being drilled in other OUs. The purpose of these samples is to better define the nature and extent of contamination and contaminant movement deep in the aquifer. The geophysical data acquired will provide information helpful for future fate and transport modeling and will help locate preferential pathways for contaminant movement.

A3.2.1.1 PUREX

A vadose zone well within the PUREX Area (299-E24-23) was drilled adjacent to the 216-A-4 Crib (Figure A3-1). This well was deepened to basalt and was sampled for the full 44 COPCs (see Table A2-1). Sediments were sampled for geochemical and geotechnical parameters required for modeling and remedial evaluation. This well assesses whether the COPCs have moved deep in an area known for high contamination.

Three wells (A-2, A-5 and A-30) are scheduled to be drilled in the 216-A-2, 216-A-5 and 216-A-30 Crib areas (Figures A3-1 and A3-2) during Phase I. These wells will be opportunistically sampled for the constituents presented in Tables A3-2 and A3-3. The plan is to extend these wells to basalt and sample for the full 44 COPCs. The sediments also will be sampled for geochemical and geotechnical parameters required for modeling and remedial evaluation. These wells will help assess whether COPCs have moved deep in the aquifer in a known area of high contamination.

The results of the data from these wells, coupled with the results from the electrical resistivity characterization being conducted, will assist in characterization of the area surrounding the 216-A-36B and 216-A-37-1 Cribs.

All wells chosen for sampling within the PUREX area will have alkalinity and ammonium (RCRA constituents) added to the COPCs as noted on the well table provided in Tables A3-2 and A3-3.

A3.2.1.2 BC Cribs and Trenches Area

A previous assessment of the capability of the BC Cribs and Trenches Area wells determined that the wells chosen are accessible and producing water. Twelve wells in this area will be sampled once, using the routine SAP constituents. If any constituent exceedances are exhibited, the well will be sampled once more. The analytical results will be reviewed from new borings where groundwater samples are collected to determine whether added groundwater wells are needed and assess whether any contamination has reached groundwater. Three planned borings in the BC Crib and Trenches Area (A, C, and E) shown in Figure A3-3 will be opportunistically sampled for the full 44 analytes listed in Table A1-2. Additional borings B, D, C4732, and C4733 also are shown in Figure A3-3. These are proposed by the BC Crib Waste Site OU, and are outside the scope of this Work Plan.

Table A3-2. Sampling and Analysis for Wells Chosen in the 200-PO-1 Groundwater Operable Unit.

DRAFT DRAFT DRAFT

			Metals											VOCS & SVOCS																Radiological										Pesticides				Anions			Supporting Parameters							Supporting Constituents											
Geographic Area	200-PO-1 Well Identification	Sampling Frequency	Antimony	Arsenic	Cadmium	Chromium	Lead	Manganese	Nickel	Thallium	Uranium	Vanadium	Zinc	1,1,2,2-Tetrachloroethane	1,2-Dichloroethane	1,4-Dioxane	Benzene	Bromodichloromethane	Carbon tetrachloride	Dibromochloromethane	Hexane	Methylene chloride	Tetrachloroethene	Trichloroethene	Vinyl chloride	2,4-Dinitrophenol	Bis (2-ethylhexyl) phthalate	Nitrobenzene	Pentachlorophenol	Gross alpha	I-129	Np-237	Pa-231	Se-79	Sr-90	Tc-99	Tritium	U-234	U-238	Dieldrin	Dimethoate	Heptachlor	Heptachlor epoxide	Fluoride	Nitrate	Nitrite	Specific conductance	Temperature	Turbidity	DO	Alkalinity	pH	Water level	Ammonium	Hexavalent chromium	Cyanide	Co-60	Total Organic Carbon	Mercury	Anions (a)	Gross beta	Gamma	Total Organic Halides	Metals (b)	VOCs (c)
BC Crib	299-E13-11	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-12	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-14	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-16	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-17	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-18	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-19	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-4	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-5	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-6	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-8	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-9	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
Near Field Basalt Confined Aquifer- Annual	299-E16-1	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
PUREX shallow unconfined- Annual	299-E17-14	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X			X											
IDF RCRA site well	299-E17-21	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
	299-E24-3	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
PUREX Area	299-E24-23	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Down gradient WTP A-AX and A-29 Ditch	299-E25-25	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	299-E25-39	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
A-AX Tank Farm	299-E25-93	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
400 Area screened lower than adjacent wells	499-S1-8J	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-10-E12	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-10-54A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-13-1C	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect	699-20-E12O	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-24-1P	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-24-46	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect LPU	699-25-33A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-26-33	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-31-31	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-32-22A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-32-22B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-32-43	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
BC Cribs	699-33-56	Annually		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
River trenches TUC	699-41-1A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-41-23	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-42-40C	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-46-21B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-46-4	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-S11-E12AP	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-S19-E13	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer close to LIGO	699-S2-34B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-S3-E12	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Opportunistic well PUREX Area	A-30	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic well PUREX Area	A-5	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic well PUREX Area	A-2	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic WMA A-AX Tank Farm Well	A-7	Unknown	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic BC Crib Area	A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic BC Crib Area	C	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic BC Crib Area	E	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	C	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	D	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Aquifer tubes (new) along river corridor																																																																		
1	AT-1U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-1M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-1L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
2	AT-2U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-2M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-2L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
3	AT-3U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-3M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-3L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
4	AT-4U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-4M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-4L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
5	AT-5U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-5M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-5L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
6	AT-6U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-6M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-6L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
7	AT-7U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-7M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-7L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
8	AT-8U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-8M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-8L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
9	AT-9U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-9M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-9L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
10	AT-10U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-10M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-10L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										

(a) Anions include but are not limited to nitrate.
(b) Metals include but are not limited to chromium, manganese, and vanadium.
(c) VOCs - Analytes include but not limited to trichloroethene, 1,1-dichloroethene, 1,2-dichloroethene, tetrachloroethene, and vinyl chloride
IDF= Integrated Disposal Facility
LIGO=Laser Interferometer Gravitational-Wave Observatory
LPU- lower permeability unit
RT- river transect
SET- south-east transect
TBD= to be decided
TUC= top of the unconfined aquifer
UUC= upper unconfined aquifer

Table A3-3. Sampling and Analysis for Candidate Wells Chosen in the 200-PO-1 Groundwater Operable Unit.

DRAFT DRAFT DRAFT

			Candidate for Decommissioning Wells																																																												
			Metals											VOCS & SVOCS																Radiological										Pesticides							Anions			Supporting Parameters											Supporting Constituents								
Well Depths	Candidate Wells ID (a)	Sampling Frequency	Antimony	Arsenic	Cadmium	Chromium	Lead	Manganese	Nickel	Thallium	Uranium	Vanadium	Zinc	1,1,2,2-Tetrachloroethane	1,2-Dichloroethane	1,4-Dioxane	Benzene	Bromodichloromethane	Carbon tetrachloride	Dibromochloromethane	Hexane	Methylene chloride	Tetrachloroethene	Trichloroethene	Vinyl chloride	2,4-Dinitrophenol	Bis (2-ethylhexyl) phthalate	Nitrobenzene	Pentachlorophenol	Gross alpha	I-129	Np-237	Pa-231	Se-79	Sr-90	Tc-99	Tritium	U-234	U-238	Dieldrin	Dimethoate	Heptachlor	Heptachlor epoxide	Fluoride	Nitrate	Nitrite	Specific conductance	Temperature	Turbidity	DO	Alkilinity	pH	Water level	Ammonium	Hexavalent chromium	Cyanide	Co-60	Total Organic Carbon	Mercury	Anions (b)	Gross beta	Gamma	Total Organic Halides	Metals (c)	VOCs (d)
Unknown depth	299-E24-6	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X												
Unknown depth	299-E25-21	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Unknown depth	299-E25-23	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Unknown depth	299-E25-24	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Unknown depth	699-10-30B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-13-26	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Unknown depth	699-17-24	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-18-21	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
300-399 feet in depth	699-18-25A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-19-23	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Unknown depth	699-20-E8	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-23-33	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-25-20	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-31-17	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-31-8	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
100-199 feet in depth	699-32-18	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-33-14	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-35-16	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
100-199 feet in depth	699-35-19B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-36-17	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
100-199 feet in depth	699-37-E1	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-38-19	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Greater than 500 feet in depth	699-39-23	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Unknown depth	699-40-28	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
100-199 feet in depth	699-41-25	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
400-499 feet in depth	699-42-21	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
400-499 feet in depth	699-43-18	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-S6-E4C	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-S5-E16A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-S5-E16B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-S6-E4J	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-10-3A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-12-1B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-16-E3A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-7-6	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-4-E16	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-13-E14	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-2-E14	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-15-E13	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-11-E10	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-S6-E14A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-S5-16B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	699-S6-E16B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			

(a) All wells that are candidates for decommissioning (CD) will be checked for sampling utility prior to decommissioning. If water is available a single grab sample will be taken prior to decommissioning. Wells can be added or removed from this list depending on the utility of sampling and the availibility of water.

(b) Anions include but are not limited to nitrate.

(c) Metals include but are not limited to chromium, manganese, and vanadium.

(d) VOCs - Analytes include but not limited to trichloroethene, 1,1-dichloroethene, 1,2-dichloroethene, tetrachloroethene, and vinyl chloride.

Figure A3-1. Location of Wells (A-2, A-4, and A-5) in the PUREX Area to be Opportunistically Sampled for 200-PO- Groundwater Operable Unit Analytes.

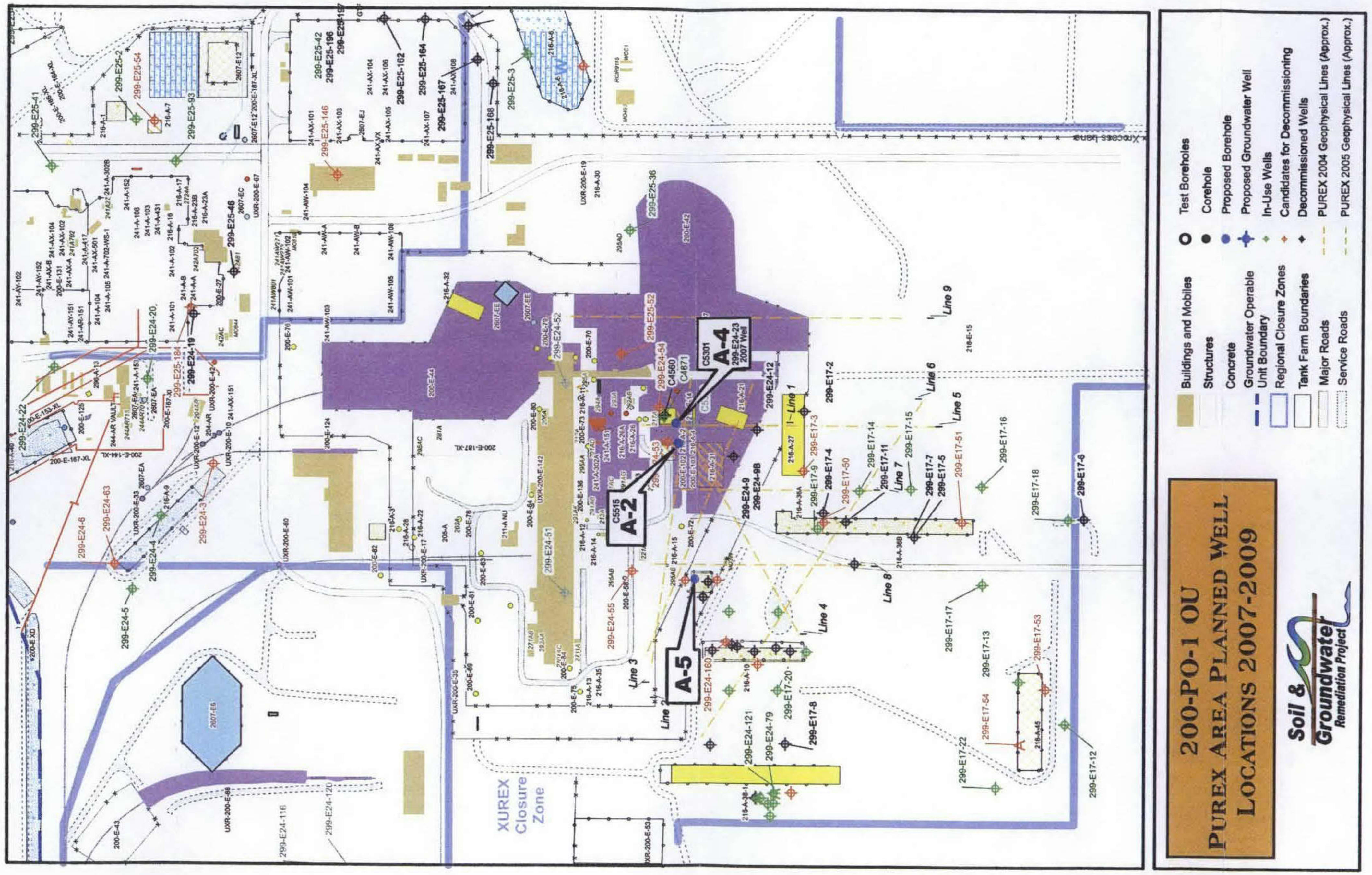


Figure A3-2. Location of Well A-30 in the PUREX Area to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.

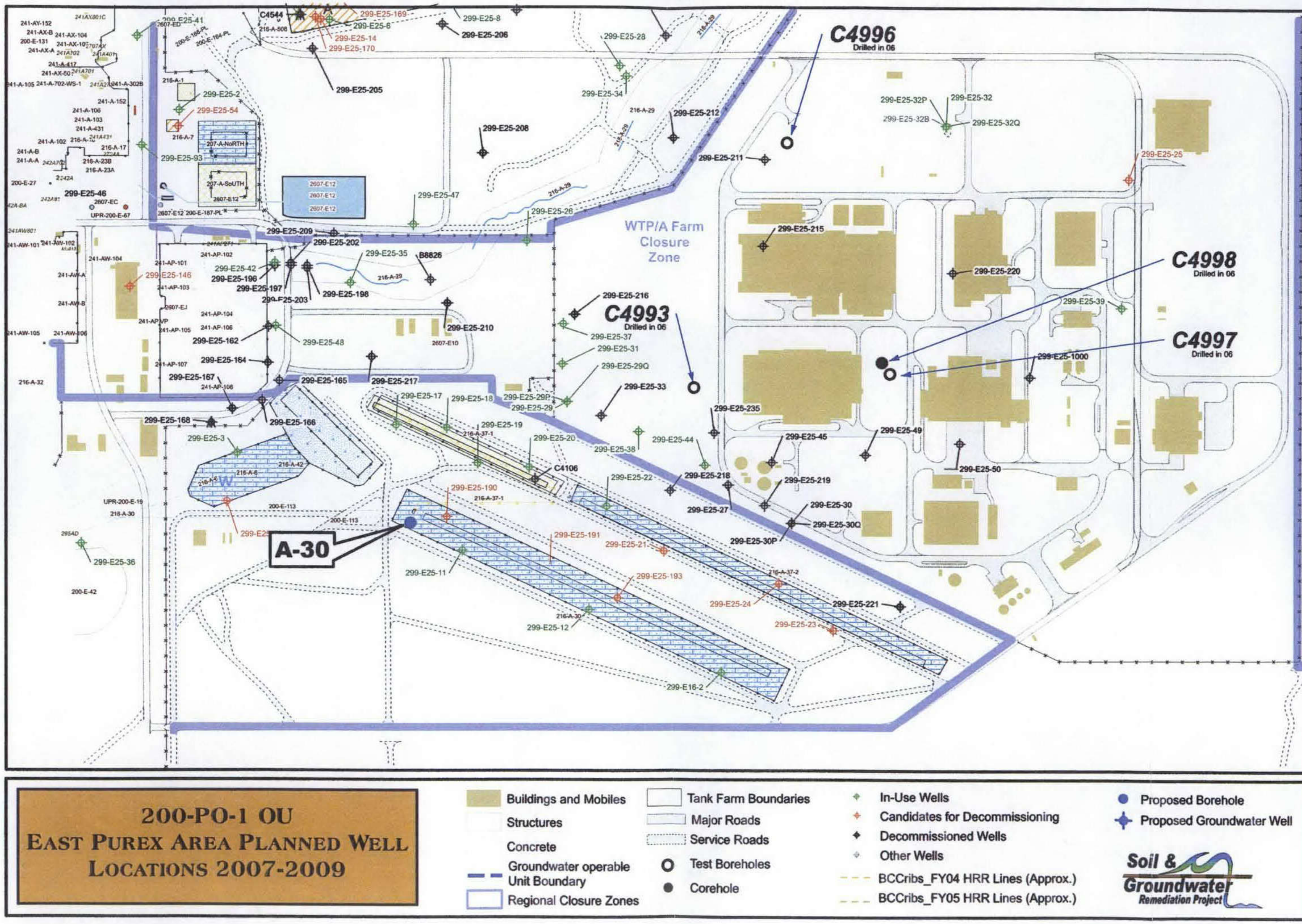
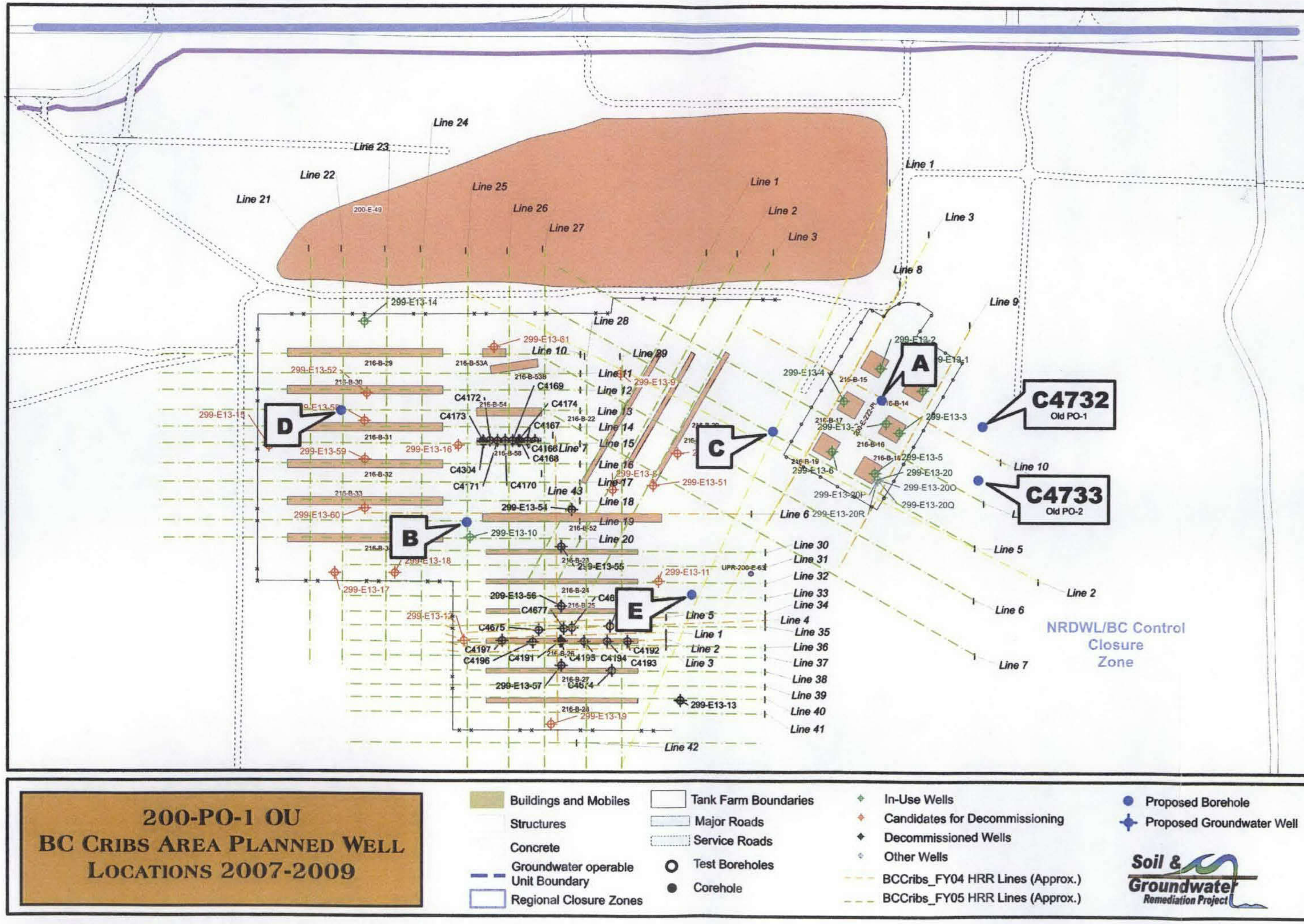


Figure A3-3. Location of BC Cribs and Trenches Area Wells to be Opportunistically Sampled for the 200-PO-1 Groundwater Operable Unit.



A3.2.2 Phase I Far-Field Tasks

Far field is defined as the areas concerning the Treated Effluent Disposal Facility, B Ponds, NRDWL, Solid Waste Landfill, 400 Area wells, SET wells, and the RT and corridor wells. These wells will be used to collected data on groundwater contaminants, acquire geophysical data to estimate vertical and lateral extent of contamination, and refine or confirm preferred contaminant pathways.

A3.2.2.1 River Transect Wells

Five existing RT wells were chosen for sampling and analysis. These wells will have all 44 COPCs analyzed annually. These analyses will determine the extent of contamination for the purposes of risk assessment along the river.

A3.2.2.2 Southeast Transect Wells

Nine existing wells were chosen along the SET. These wells will have all 44 COPCs analyzed annually.

A3.2.2.3 Aquifer Tubes

Ten aquifer tube stations (each station is 3 vertical tubes) will be installed and sampled along the river (see Figure A3-7 in Section A3.9). Each set of 3 will be vertically placed within the upper, middle, and lower aquifer. The purpose of these new aquifer tubes is to acquire contaminant data within a geographic area that has not been sampled thus far; the data are needed for risk assessment, especially ecological risk assessment. Coordinates of each set will be taken and markers will be placed within the substrate for ease of relocation. More tubes may be added in Phase II if the information from the geophysical characterization so suggests.

A3.2.2.4 Candidate Wells

Forty-three candidate for decommissioning wells were selected to be evaluated for sampling utility. Any wells that are open and reasonably deep will be logged, at a minimum. If the candidate well is open and has water, it will be logged and will have a grab sample taken before decommissioning. If it is determined that the utility of each well on the list is available for sampling, then each well will be sampled once for the 44 constituents listed in Table A1-2. If any constituent exhibits exceedances, the well will be sampled once more. In addition, if the wells are capable of being sampled, gradient and head data could be collected using a gyroscope to quantify water table data. Note that the candidates for decommissioning wells that have been chosen for sampling may change as data become available on sampling utility (e.g., water availability and physical access) and as other wells are placed on the candidate list.

A3.2.2.5 Nonradioactive Dangerous Waste Landfill

Samples will be collected to evaluate geophysical results to determine preferential pathways. Data from RCRA wells will be evaluated.

A3.2.3 Phase II

Phase II objectives are to evaluate Phase I results, including collecting and evaluating additional data as they come in to accomplish Phase I objectives and conduct a baseline risk assessment.

Up to four new wells will be drilled to the top of basalt in Phase II. The decision to drill the wells through the saturated zone will be made by the project team, based on the results of sampling and analysis completed in Phase I. An opportunistic well (A-7) within the 216-A-7 Crib area has been selected for analysis of the full 44 COPCs in Phase II (Figure A3-4).

A3.3 WELL DRILLING AND DESIGN

A3.3.1 Well Locations

Design and construction of new wells will be in accordance with WAC-173-160, "Minimum Standards for Construction and Maintenance of Wells," and will have casing and screen diameter of at least 15.2 cm (6 in.). Figure A3-5 illustrates and provides an example of the basic design of a completed new well. While Figure A3-5 provides an example of well design, details and well specifications will be provided in drilling contractor statement of works. Separate planning documents for drilling activities, design specifications, and management of investigation-derived waste will be required.

A3.3.2 Aquifer Tubes Installation

The aquifer tubes are installed by a portable air hammer direct-driving a temporary casing into the sediments. The screened end of each tube is lowered through the casing to the desired sampling depth, and the temporary casing is withdrawn. Tubes are commonly installed in sets of three at each individual location (shallow, medium, deep) using three separate casings. A description of the tubes and a discussion of tube installation, practical limitations, and procedures for sampling may be found in BHI-01090, *Description of Work for Installing Aquifer Sampling Tubes Along the 100 Area and Hanford Townsite Shorelines*.

The goal at each location will be to install aquifer tubes with ports near the bottom of the unconfined aquifer, at aquifer mid-depth, and within approximately 1.5 m (5 ft) of the water table. It is recognized that the direct-drive method is limited by hard, impenetrable layers or boulders, but the top of the Ringold upper mud unit in the project area is expected to be within the ~9 m (~30-ft) depth limit of the air hammer.

Figure A3-4. Location of PUREX Well (A-7) Adjacent to the 216-A-7 Crib to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.

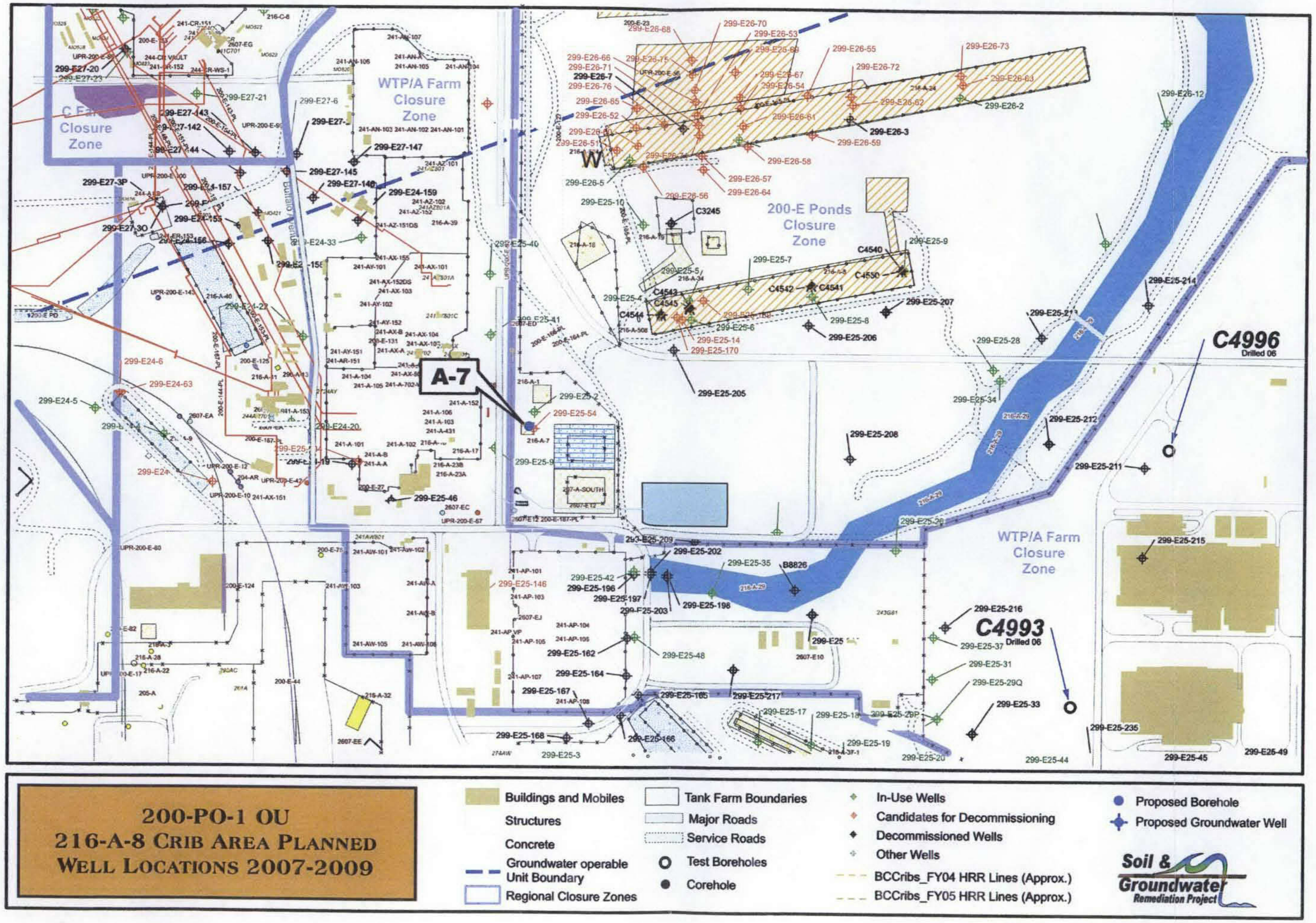
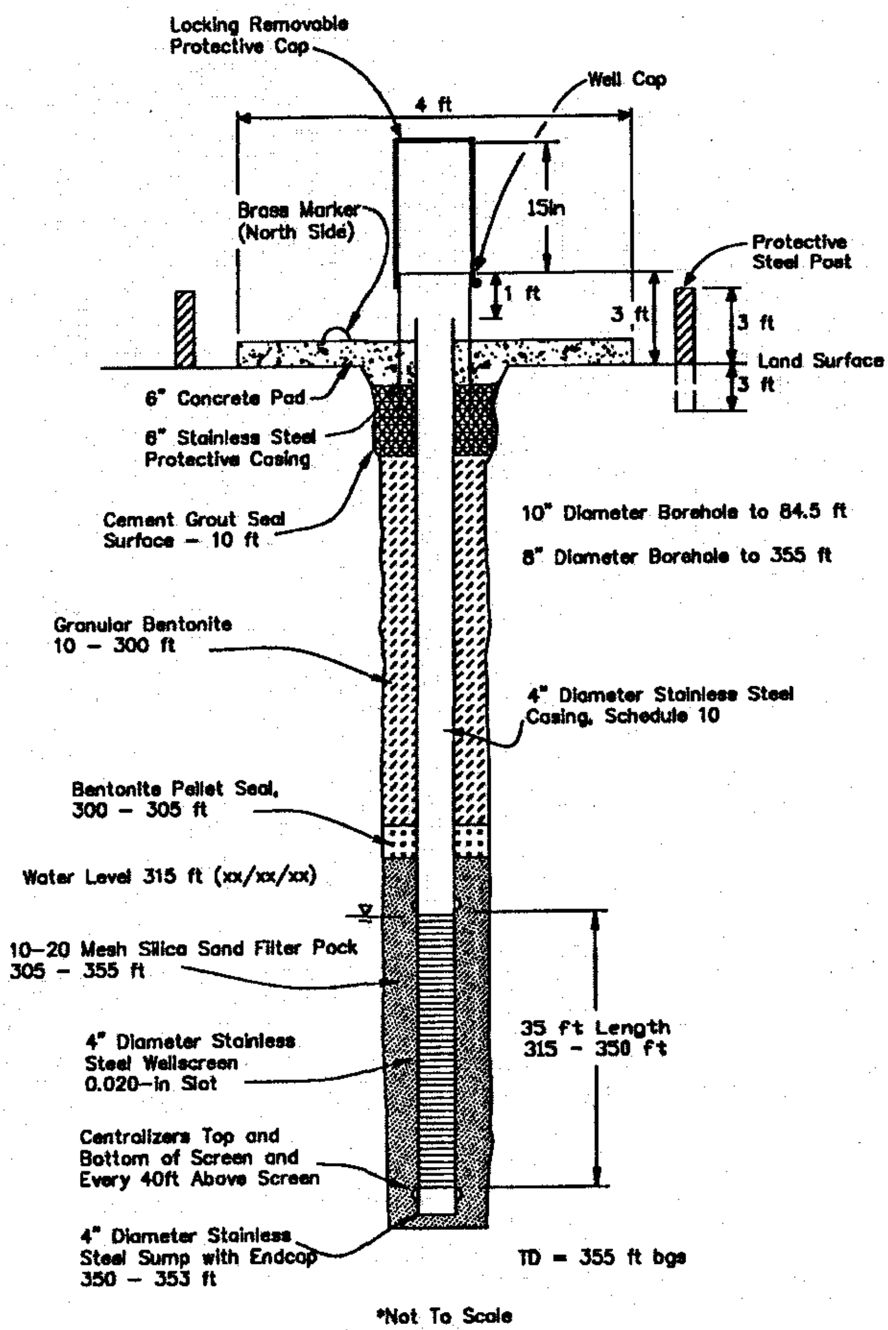


Figure A3-5. Example Design for New Wells Drilled to Top of Basalt.



A3.3.3 Sediment Sampling

Grab samples of the drill cuttings will be collected at 1.5 m (5 ft) intervals, starting 1.5 m (5 ft) below ground surface, and at recognized changes in lithology. The samples will be archived in pint jars and chip trays. Chips trays allow for sediment samples to be stored in lithological order.

The estimated thickness of the suprabasalt saturated interval in the vicinity of the planned new wells is 45 to 60 m (150 to 200 ft). Within the saturated interval, a split-spoon sample will be collected for geotechnical examination (e.g., sieve analysis) at significant changes in lithology, and at intervals of no more than 12 m (40 ft).

A3.3.4 Groundwater Sampling During Well Construction

Within the saturated zone, groundwater sampling will be collected from an interval at and just above the split-spoon sampling intervals. After the split-spoon sample has been collected, the temporary well casing will be withdrawn 1.5 m (5 ft). A temporary screen and pump will be installed in the open interval of the well. The well will be developed per FH procedures, and a groundwater sample will be collected for analysis according to Table A1-3. It is recognized that development of the screened open hole may be problematic and that reaching turbidity <5 NTU may not be a practical reality. In such a case, higher turbidity is acceptable if at least three bore volumes of groundwater have been removed by pumping.

A3.3.5 Well Development of Completed Wells

Wells will be developed by pumping according to FH procedures, including measurement of field parameters, water level monitoring, and collection of a groundwater sample for analysis per Table A1-3. All new or deepened wells, and existing wells designated by the project team, will be geochemically and hydrologically profiled using methods summarized in the following sections.

A3.3.6 Slug Testing of Completed Wells

After the well has been developed, a slug test will be performed using FH procedures to measure the mean hydraulic conductivity of the aquifer in the vicinity of the well.

A3.3.7 Hydraulic Conductivity Profile

Either an electromagnetic borehole flowmeter or geochemical point-dilution testing will be used to measure hydraulic conductivity (and relative flow velocity) as a function of depth. Measurements will be made at ~1 m (3-ft) intervals within the standing water column of each new well. The results of testing will be used to estimate the period of time necessary for water within the standing water column to be replaced by groundwater from the aquifer under conditions of natural flow.

A3.3.8 Depth-Discrete Groundwater Sampling

Depth-discrete sampling and analysis will be performed at least once for each well to detect and quantify vertical stratification of contaminant concentrations. The sampling will be done at ~1 m (3-ft) intervals that coincide with the intervals measured according to Section A3.2.1. The samples will be collected using a KABIS sampler[1], Solinst[2] Model 425 Discrete Interval Sampler, or similar device. The order of sampling will be from the shallowest sample to the deepest sample, to avoid the effects of vertical mixing caused by movement of the sampler within the well bore. At other times, packers may be used to isolate the portion of the screen where samples will be collected.

The depth-discrete samples will be chemically analyzed for major waste constituents, based on the results of initial sampling per Section A3.1.4.

Activities such as pumping, bailing, or the removal or installation of hardware can disturb the standing water column such that depth-discrete samples may not be representative of the adjacent aquifer. Thus, the depth-discrete samples should be collected only after the period of time required for the water within the well bore to be replaced by water from the adjacent aquifer, as calculated based on test results from Section A3.2.1.

A3.4 SAMPLING PROCEDURES

Standard FH procedures for groundwater sampling under the groundwater monitoring SAP (DOE/RL-2003-04) will be used except as otherwise specified in this plan. Where procedural modifications are needed, separate written instructions will be supplied.

A3.5 SAMPLE MANAGEMENT

Sample and data management activities will be performed in accordance with FH QA program plans. Section A2.6 presents additional information regarding QC.

Sample preservation, container, and holding-time requirements will be specified on Sampling Authorization Forms and Chain-of-Custody Forms in accordance with FH procedures. Project requirements are listed in Table A2-2.

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[1] KABIS sampler is a product of SIBAK Industries Limited, Inc., Peoria, Illinois (admin) and San Marcos, California (R&D)

[2] Solinst is a trademark of Solinst Canada Limited, Georgetown, Ontario, Canada.

A3.6 SAMPLE CUSTODY

All samples obtained during the project will be controlled from the point of origin to the analytical laboratory, as required by the Hanford Site internal laboratory QA requirements, and applicable FH procedures. Section A2.6 presents information regarding sample custody.

A3.7 SAMPLE PACKAGING, SHIPPING, AND FIELD DOCUMENTATION

Field documentation will be kept in accordance with the Hanford Site internal laboratory QA requirements and FH procedures pertaining to the following:

- Environmental information systems - sample documentation processing
- Geologic logging
- Chain of custody/sample analysis requests
- Notebooks and logbooks.

Section A2.6 provides further information regarding sample packaging and shipping.

A3.8 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste from these sampling activities will be managed according to "Environmental Restoration Program Strategy for Management of Investigation Derived Waste," (Ecology, EPA, and DOE, 1999) and a waste control plan approved by the lead agency (DOE) and the lead regulatory agency (Ecology). The anticipated waste streams associated with the activities incorporated in this SAP include the following:

- Miscellaneous solid waste such as filters, wipes, gloves, and other personal protective equipment, cloth, sampling and measuring equipment, pumps, pipe, wire, plastic sheeting, tools, bentonite, sand, paper, wood, construction debris, stainless steel or carbon steel metal, and glass

- Purgewater generated during groundwater well installation, development, testing, monitoring, maintenance, and decommissioning

- Purgewater generated during decanting of soils and slurries

- Decontamination fluids

- Liquids generated during field analysis

- Drill cuttings and associated wastes

- Materials generated from cleanup of unplanned releases

- Equipment and construction material (e.g., well casing, drill string, drive barrel, decommissioning materials, wooden pallets, etc.).

A separate DQO summary report will be required to control the handling, designation, and disposition of waste derived from the installation or deepening of wells associated with this SAP. The waste DQO and the waste control plan will be completed and approved before initiation of drilling activity.

Unused sample and associated laboratory waste will be disposed of in accordance with the approved waste control plan and the laboratory contract and agreements for return to the Hanford Site. In accordance with 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-site Response Actions," FH technical project lead approval is required before returning unused samples or associated waste from offsite laboratories to FH.

A3.9 GEOPHYSICAL, GEOCHEMICAL, AND INSTRUMENTAL CHARACTERIZATION

Geophysical and geochemical tracer methods were briefly introduced in Section A1.5. The use of an electromagnetic borehole flowmeter for profiling hydraulic conductivity in wells has been established by past practice at the Hanford Site. However, these services are contractor-offered and not standard FH procedures. Therefore, standards for operations, QA, and interpretation will be supplied by the contractor pursuant to FH's description of work. Test sites will be chosen by the project team.

Wells for innovative borehole geophysics, if proven feasible, will be chosen by the project team. Target areas for high-resolution reflection seismic and electrical resistivity characterization are shown in Figure A3-6. Figure A3-7 shows the target area for airborne electromagnetic survey as well as a smaller target area encompassing the river transect for demonstration and evaluation of the method for the Hanford Site.

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Figure A3-6. Target Areas for High-Resolution Reflection Seismic Geophysical Investigation.

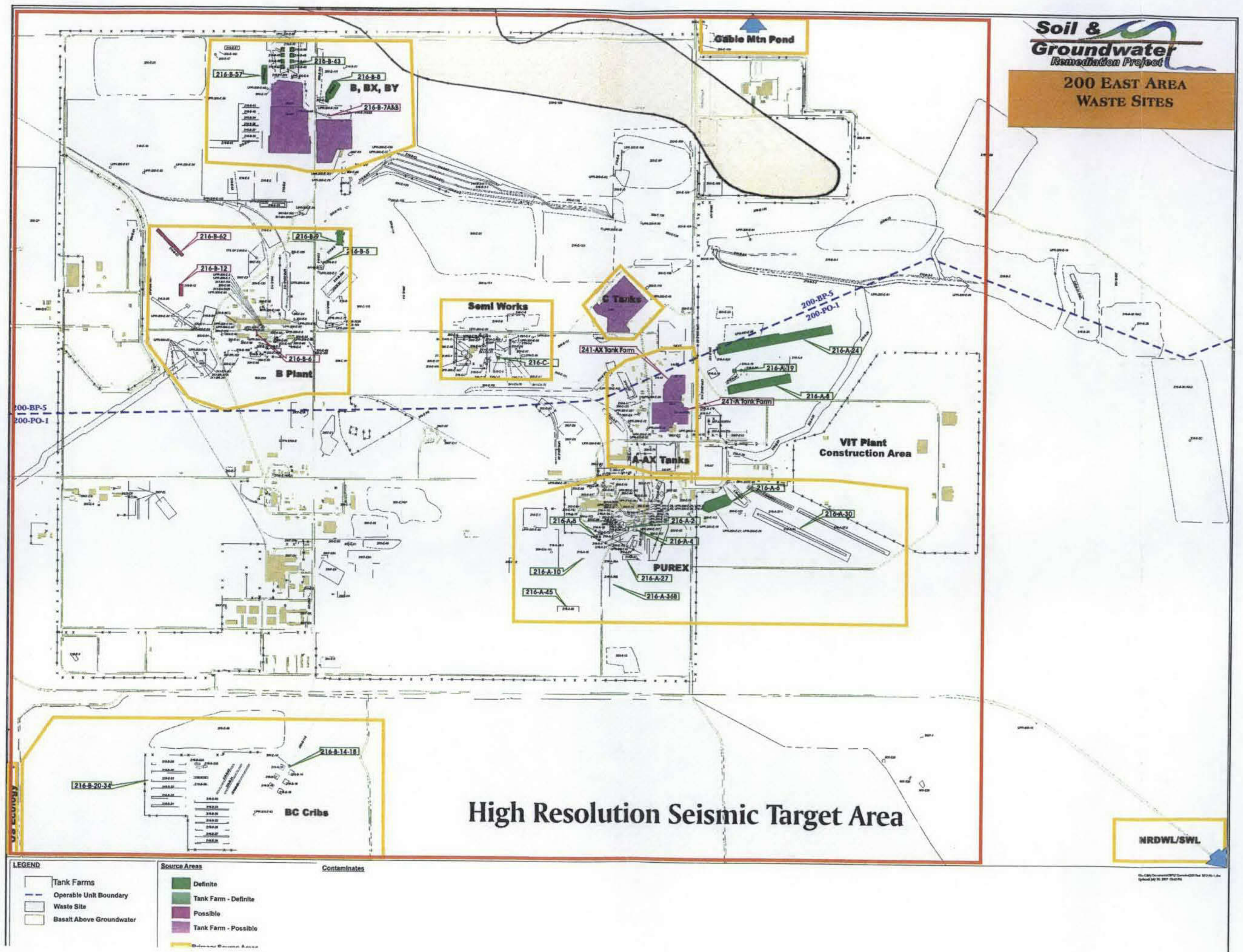
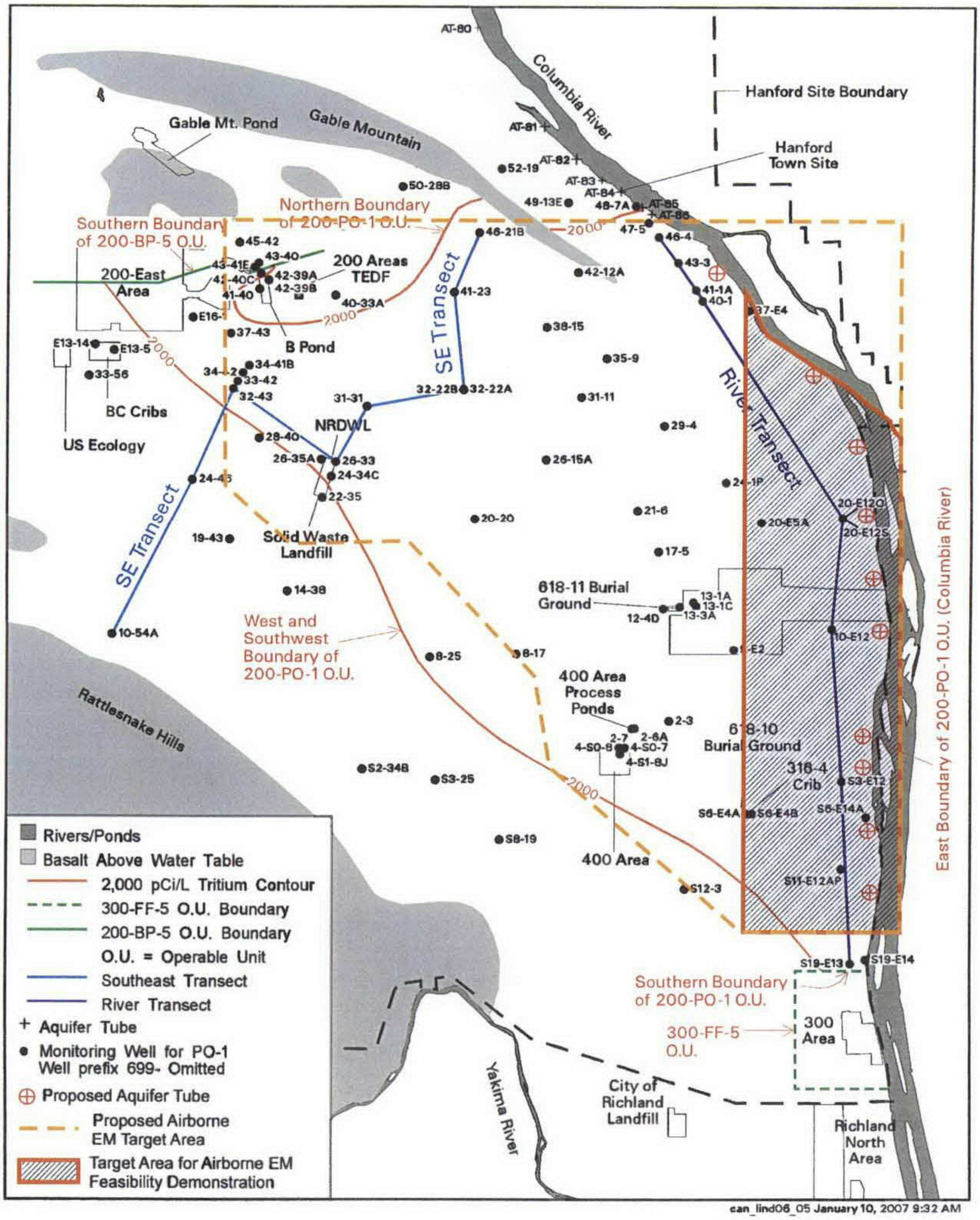


Figure A3-7. Proposed Target Area and Demonstration Target Area for Airborne Electromagnetic Characterization.



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A4.0 HEALTH AND SAFETY

All personnel working at the drilling sites addressed by this SAP will have completed the following, at a minimum:

- Occupational Safety and Health Administration Act 40-hour Hazardous Waste Site Worker training program (29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response")
- Hanford General Employee Training
- Hanford Radiation Worker II training.

Work will be performed in accordance with the following policies, specifications, or procedures:

- Site-specific plans, as applicable:
  - Health and safety plans
  - Radiological Work Permit, as applicable
  - Activity hazard analysis/job safety analysis
  - Site-specific Waste Packaging Instruction
- HNF procedures
- Central Plateau Radiological Control Procedures
- FH Environmental Procedures.

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A5.0 REFERENCES

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10 CFR 835, "Occupational Radiation Protection," Title 10, *Code of Federal Regulations*, Part 835.

29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," Title 29, *Code of Federal Regulations*, Part 1910.120.

40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-site Response Actions," Title 40, *Code of Federal Regulations*, Part 300.440.

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WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340, "Model Toxics Control Act -- Cleanup," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-707, "Analytical Considerations," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

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APPENDIX B

SAMPLING AND ANALYSIS PLAN FOR THE 200-PO-1 GROUNDWATER OPERABLE UNIT

This appendix contains by reference inclusion the latest version of DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*

Note: The latest version of this document is available through the Tri-Party Agreement Administrative Record and Public Information Repository, by entering DOE/RL-2003-04 in the simple search window.

http://www5.hanford.gov/arpir/search/simple.cfm

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APPENDIX C

PLATE MAPS

Plate maps are provided here in pockets.

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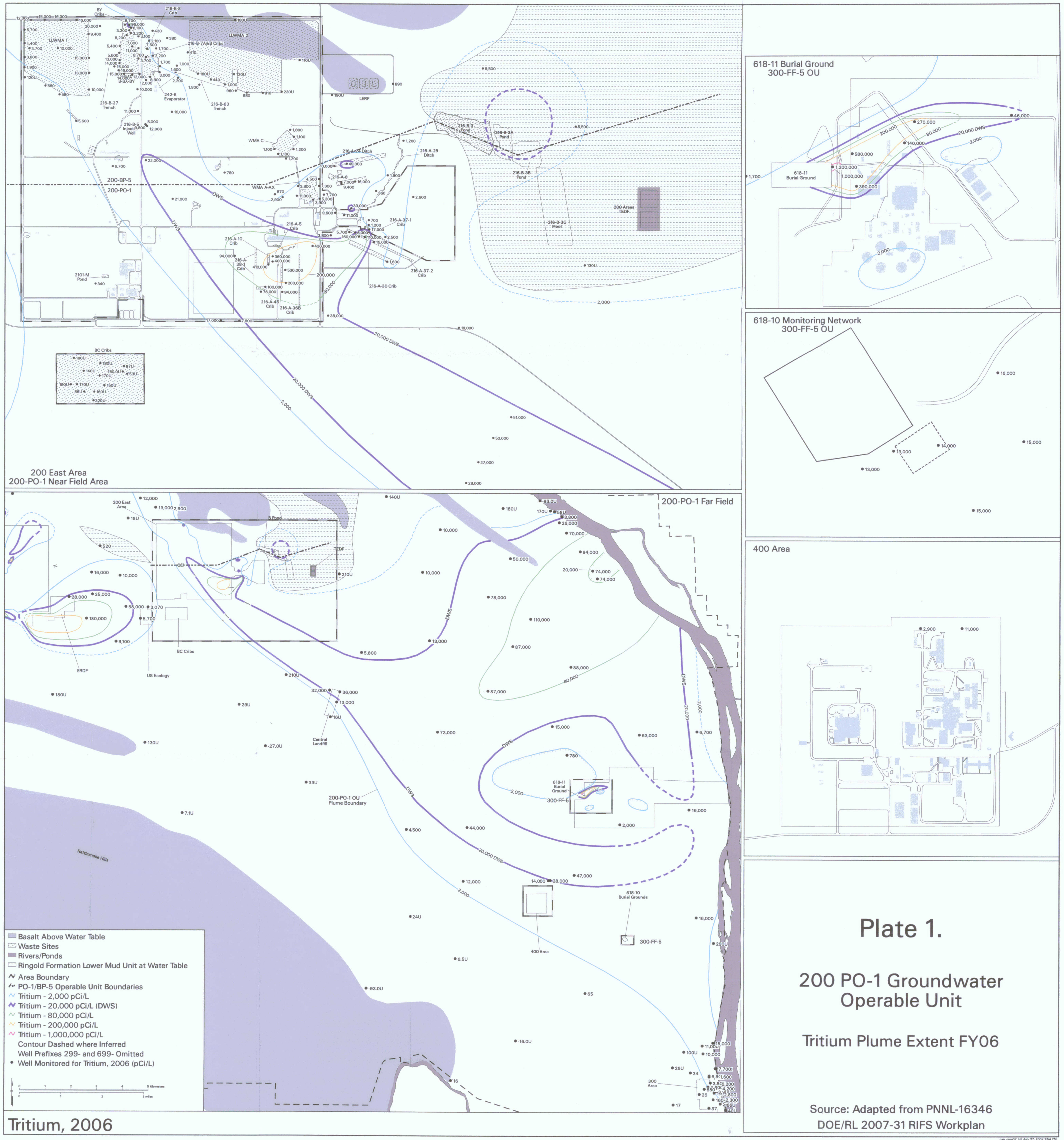


Plate 1.

200 PO-1 Groundwater Operable Unit

Tritium Plume Extent FY06

Source: Adapted from PNNL-16346
DOE/RL 2007-31 RIFS Workplan

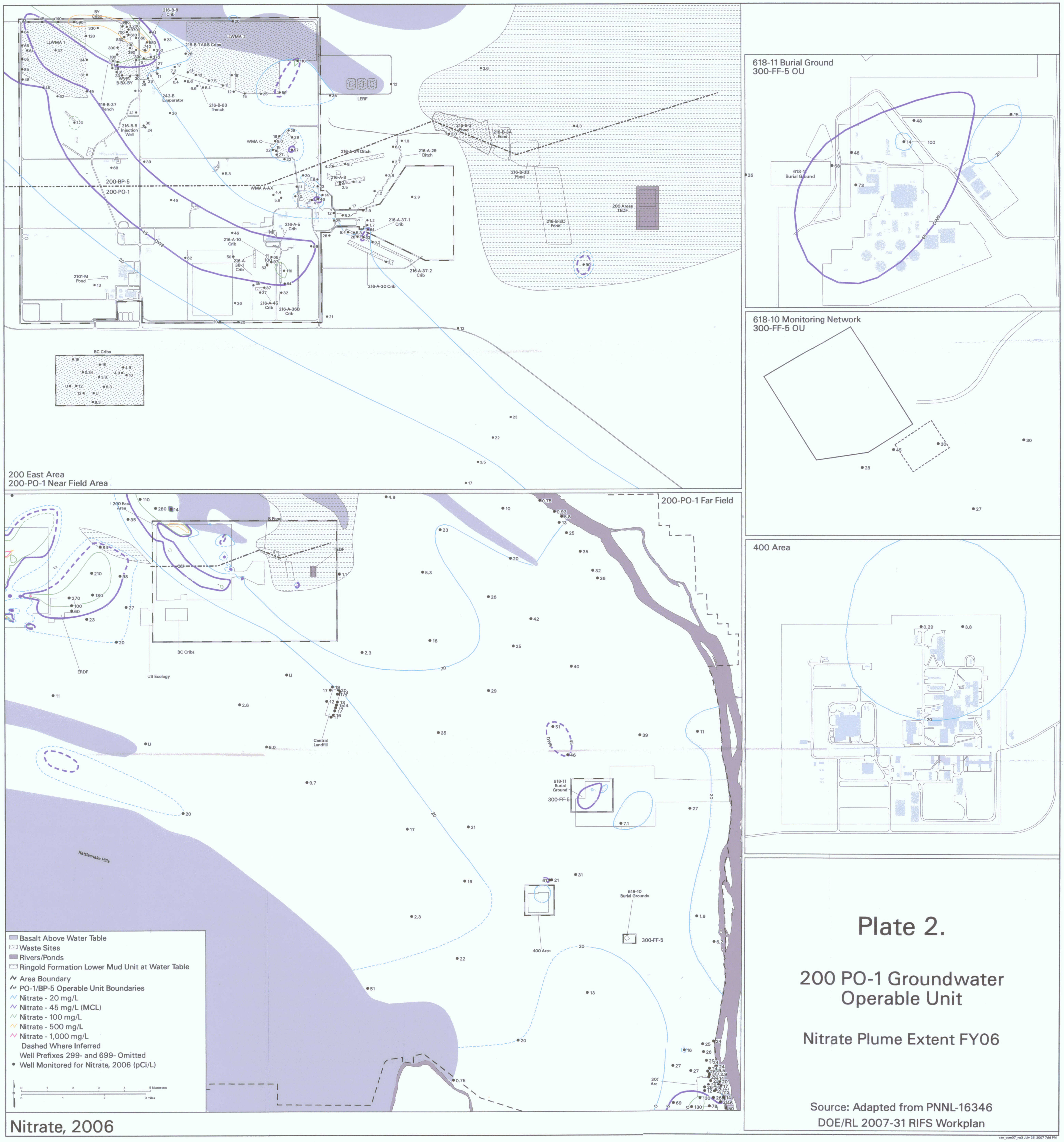


Plate 2.

200 PO-1 Groundwater Operable Unit

Nitrate Plume Extent FY06

Source: Adapted from PNNL-16346
DOE/RL 2007-31 RIFS Workplan

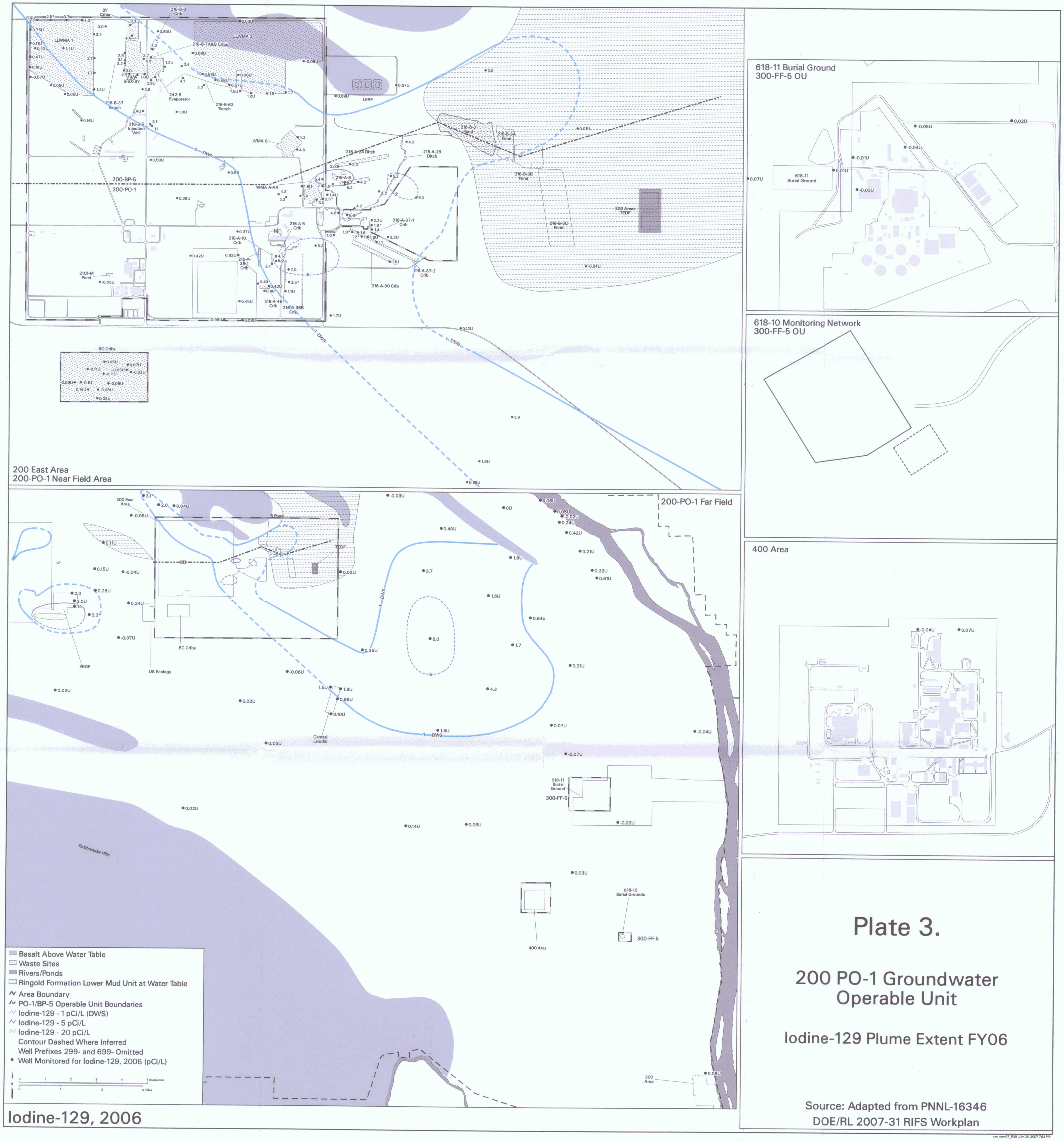


Plate 3.

200 PO-1 Groundwater Operable Unit

Iodine-129 Plume Extent FY06

Source: Adapted from PNNL-16346
DOE/RL 2007-31 RIFS Workplan

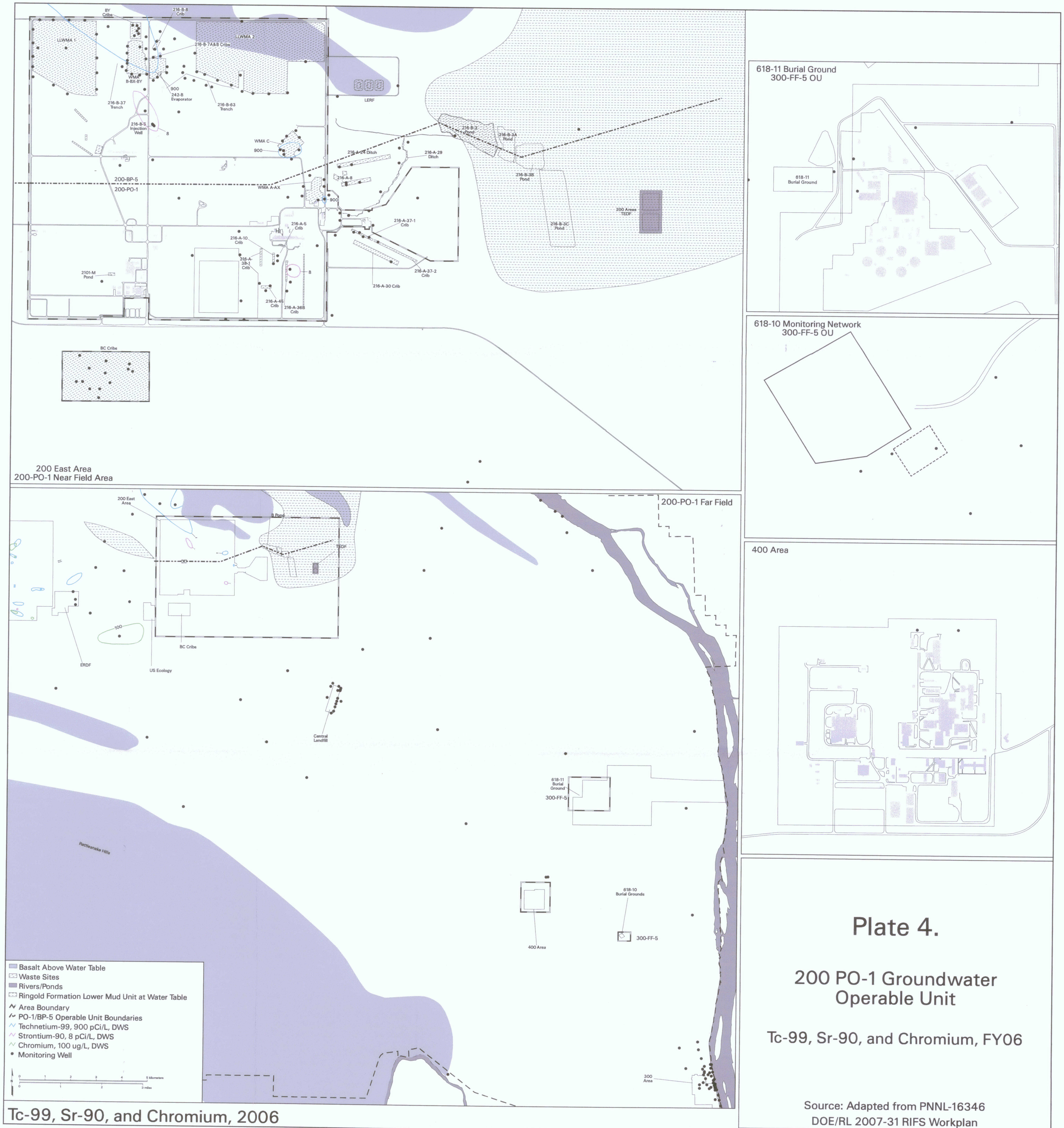


Plate 4.

200 PO-1 Groundwater Operable Unit

Tc-99, Sr-90, and Chromium, FY06

Source: Adapted from PNNL-16346
DOE/RL 2007-31 RIFS Workplan

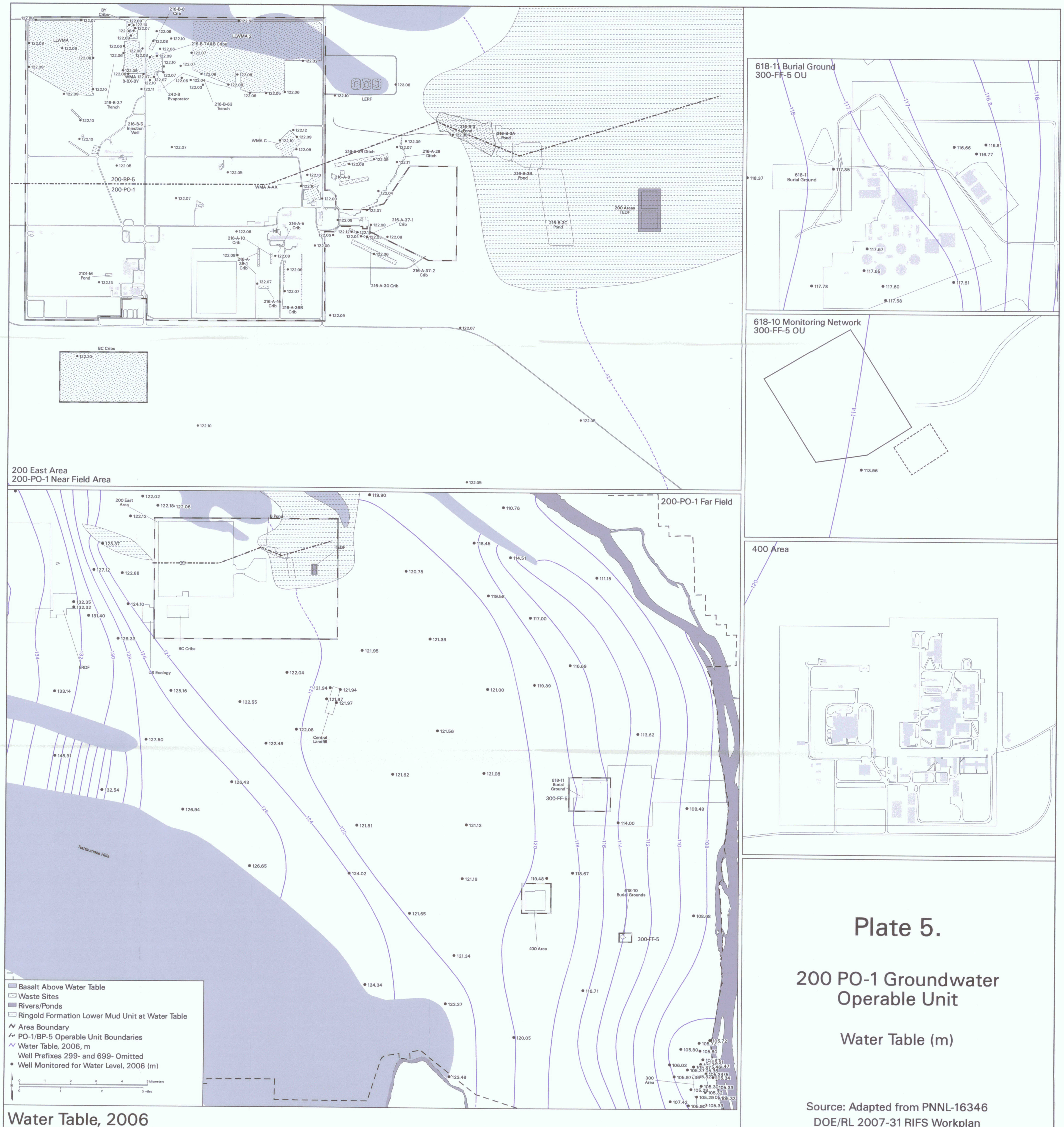
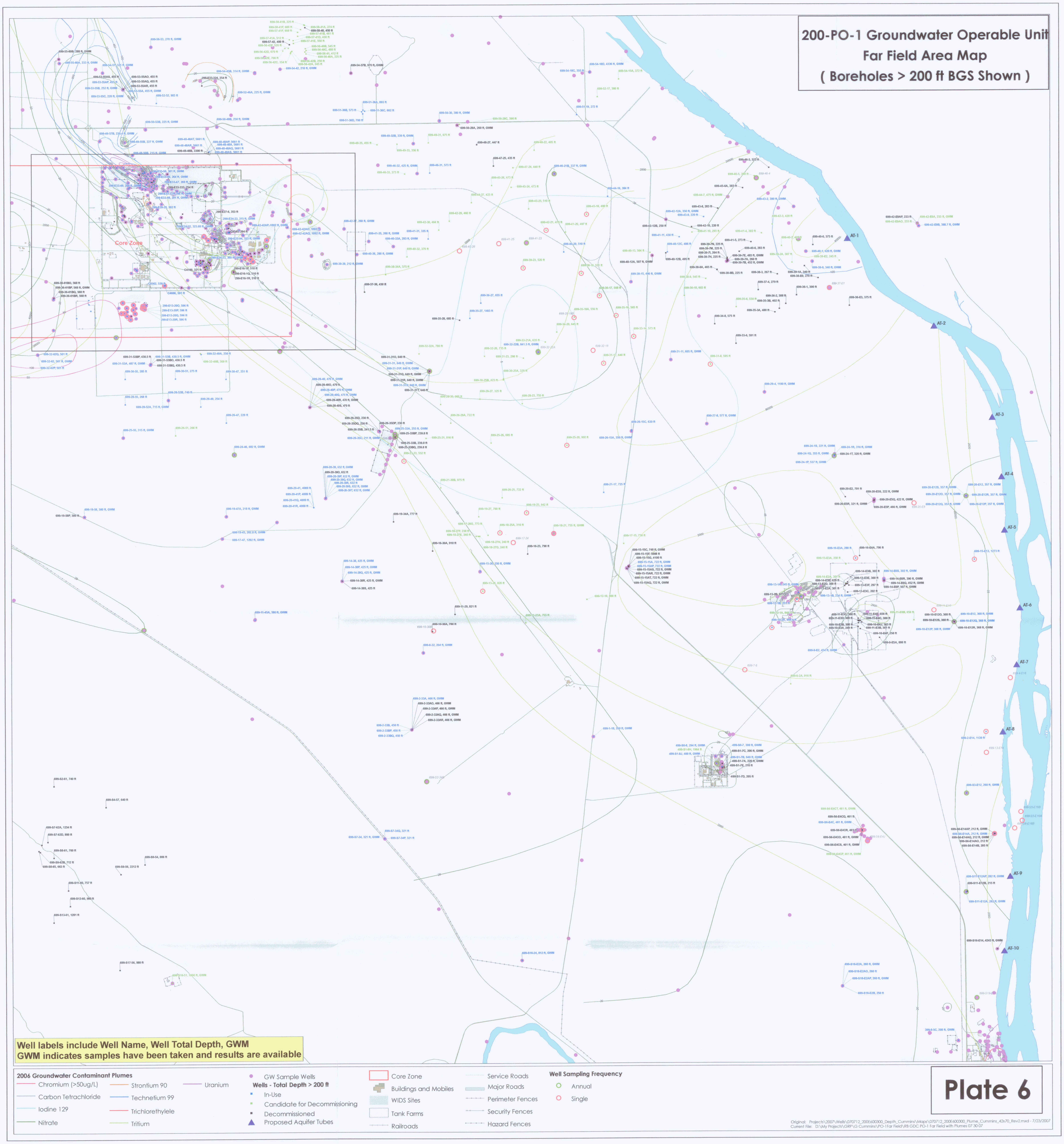


Plate 5.

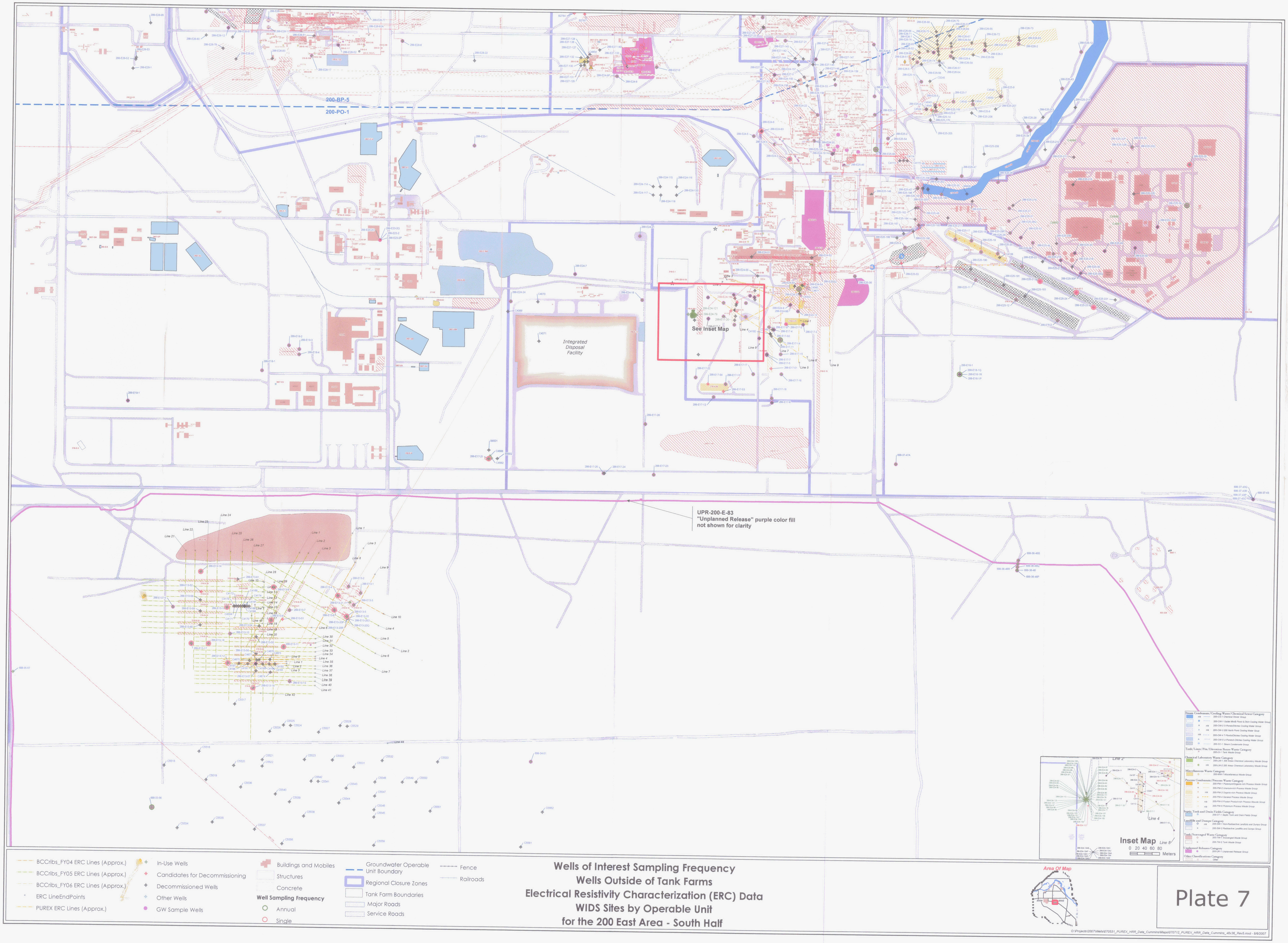
200 PO-1 Groundwater Operable Unit

Water Table (m)

Source: Adapted from PNNL-16346
DOE/RL 2007-31 RIFS Workplan



200-PO-1 Groundwater Operable Unit
Far Field Area Map
(Boreholes > 200 ft BGS Shown)
Core Zone
AT-1
AT-2
AT-3
AT-4
AT-5
AT-6
AT-7
AT-8
AT-9
AT-10
Well labels include Well Name, Well Total Depth, GWM
GWM indicates samples have been taken and results are available
2006 Groundwater Contaminant Plumes
Chromium (>50ug/L)
Carbon Tetrachloride
Iodine 129
Nitrate
Strontium 90
Technetium 99
Trichlorethylene
Tritium
Uranium
GW Sample Wells
Wells - Total Depth > 200 ft
In-Use
Candidate for Decommissioning
Decommissioned
Proposed Aquifer Tubes
Core Zone
Buildings and Mobiles
WIDS Sites
Tank Farms
Railroads
Service Roads
Major Roads
Perimeter Fences
Security Fences
Hazard Fences
Well Sampling Frequency
Annual
Single
Plate 6



Wells of Interest Sampling Frequency
Wells Outside of Tank Farms
Electrical Resistivity Characterization (ERC) Data
WIDS Sites by Operable Unit
for the 200 East Area - South Half

Plate 7

APPENDIX D

BIBLIOGRAPHY OF EXAMINED DOCUMENTS

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APPENDIX D

BIBLIOGRAPHY OF EXAMINED DOCUMENTS

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APPENDIX E

CONTAMINANTS OF POTENTIAL CONCERN

CONTENTS

FIGURE

TABLES

TERMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPC	contaminant of potential concern
EPA	U.S. Environmental Protection Agency
HEIS	*Hanford Environmental Information System* database
IRIS	*Integrated Risk Information System* database
MCL	maximum contaminant level
OU	operable unit
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
PRG	preliminary remediation goal

METRIC CONVERSION CHART

Into Metric Units

If you know	*Multiply by*	*To get*
Length	-	
inches	25.40	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles (statute)	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.0929	sq. meters
sq. yards	0.836	sq. meters
sq. miles	2.591	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces (avoir)	28.349	grams
pounds	0.454	kilograms
tons (short)	0.907	ton (metric)
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
ounces (U.S., liquid)	29.573	milliliters
cups	0.24	liters
pints	0.473	liters
quarts (U.S., liquid)	0.946	liters
gallons (U.S., liquid)	3.785	liters
cubic feet	0.0283	cubic meters
cubic yards	0.764	cubic meters
Temperature		
Fahrenheit	(°F-32)*5/9	Centigrade
Radioactivity		
picocurie	37	millibecquerel

Out of Metric Units

If you know	*Multiply by*	*To get*
Length		
millimeters	0.0394	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles (statute)
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.764	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.386	sq. miles
hectares	2.471	acres
Mass (weight)		
grams	0.0353	ounces (avoir)
kilograms	2.205	pounds (avoir)
ton (metric)	1.102	tons (short)
Volume		
milliliters	0.034	ounces (U.S., liquid)
liters	2.113	pints
liters	1.057	quarts (U.S., liquid)
liters	0.264	gallons (U.S., liquid)
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocurie

APPENDIX E

CONTAMINANTS OF POTENTIAL CONCERN

E1.0 EVALUATION OF CONTAMINANTS OF POTENTIAL CONCERN

The evaluation of contaminants of potential concern (COPC) was conducted in two Steps. Step I documented and grouped all of the historical contaminants that are known or believed to have been present in the 200-PO-1 Groundwater Operable Unit (OU) into two initial comprehensive lists, shown in Chapter 4.0 of the main document, Tables 4-2 and 4-3.

Step II entailed querying the *Hanford Environmental Information System* (HEIS) database to examine the levels of current groundwater contamination and evaluate the concentrations of COPCs as a function of time and location. Data were downloaded for all wells within the 200-PO-1 Groundwater OU from 11/01/1988 to 11/01/2006. A total of 189 wells were included in the database download. The resulting data included information on the following types of constituents: metals, nonmetals, ions, water-quality parameters, polychlorinated biphenyls and pesticides, radiological, semivolatile organic compounds, and volatile organic compounds. The results of each constituent were evaluated by comparing individual contaminant results to a selected preliminary remediation goal (PRG) (if available). In addition, Hanford Site background concentrations, where applicable, also were listed.

The results for each constituent were evaluated by comparing individual contaminant results (from actual data for existing wells) to selected PRGs. The logic for deriving the PRG limits is explained below. In addition, applicable Hanford Site groundwater background concentrations were compiled from DOE/RL-92-23, *Hanford Site Groundwater Background*. The background values in the report for metals, nonmetals, and total alpha/beta were compiled from the evaluation of data and information pertaining to the natural composition of groundwater in the unconfined aquifer system beneath the Hanford Site. Provisional background threshold levels were estimated from the data presented in the report. Background concentrations were available for many of the inorganic and radionuclide constituents, but not for organic constituents. If a background concentration for any COPC was not available, the background was assumed to be zero.

Table E1-1 lists the COPCs found in the HEIS database, as well as any applicable PRGs, derived from the U.S. Environmental Protection Agency's (EPA) maximum contaminant level (MCL) (40 CFR 141, "National Primary Drinking Water Regulations,") or WAC 173-340, "Model Toxics Control Act -- Cleanup," Method B limit; any applicable background information also is included. Assumed initial PRGs in Table E1-1 were based on the more stringent MCLs and WAC 173-340 values. The MCL levels were obtained from the EPA's drinking water standards, as published on EPA's web site in August 2003 (now found at (http://www.epa.gov/safewater/contaminants/index.html#mcls). If MCL data did not exist, WAC 173-340 Method B carcinogenic formula values (preferred) or noncarcinogenic formula values were selected. The WAC 173-340 Method B data were obtained from Ecology 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation;*

CLARC, Version 3.1, latest version now found at Ecology, 2005, *Cleanup Levels & Risk Calculations (CLARC)* database, available on the Internet at https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx.

Current MCLs for radionuclides are set at 4 mrem/yr for the sum of the doses from beta particles and photon emitters, and 15 ρCi/L for total alpha particle activity (including Ra–226, but excluding uranium and radon). The MCLs for Sr-90 and tritium are 8 ρCi/L and 20,000 ρCi/L, respectively. The MCL for total uranium is 30 µg/L (40 CFR 141.66, "Maximum Contaminant Levels for Radionuclides"). The current MCLs for beta emitters specify that the MCLs are to be calculated based on an annual dose equivalent of 4 mrem to the total body or any internal organ. It is further specified (40 CFR 141.66) that the calculation is to be performed on the basis of a 2-L/day drinking-water intake using the 168-hour data listed in NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure*. In addition, PRGs defined in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, were used when appropriate and are noted as RDR/RAWP in Table E1-1.

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
1-(o-Chlorophenyl)thiourea	5344-82-1	H		
1,1,1,2-Tetrachloroethane	630-20-6	H	WAC 173-340 B Carc	1.7
1,1,1-Trichloroethane	71-55-6	B	MCL	200
1,1,2,2-Tetrachloroethane	79-34-5	B	WAC 173-340 B Carc	0.22
1,1,2-Trichloroethane	79-00-5	B	WAC 173-340 B Carc	0.77
1,1-Dichloroethane	75-34-3	B	WAC 173-340 B Noncarc	800
1,1-Dichloroethene	75-35-4	H		
1,1-Dimethylhydrazine	57-14-7	H	WAC 173-340 B Carc	0.017
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9	B		
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	B		
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	B		
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	B		
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	39227-28-6	B		
1,2,3,4-Tetrachlorobenzene	634-66-2	H		
1,2,3,5-Tetrachlorobenzene	634-90-2	H		
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	B		
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	57653-85-7	B		
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	B		
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	19408-74-3	B		
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	B		
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	40321-76-4	B		
1,2,3-Trichlorobenzene	87-61-6	H		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
1,2,3-Trichloropropane	96-18-4	H	WAC 173-340 B Carc	0.0063
1,2,4,5-Tetrachlorobenzene	95-94-3	H	WAC 173-340 B Noncarc	4.8
1,2,4-Trichlorobenzene	120-82-1	H	MCL	70
1,2-Dibromo-3-chloropropane	96-12-8	H	WAC 173-340 B Carc	0.031
1,2-Dibromoethane	106-93-4	H	WAC 173-340 B Carc	0.00051
1,2-Dichlorobenzene	95-50-1	B	MCL	600
1,2-Dichloroethane	107-06-2	B	WAC 173-340 B Carc	0.48
1,2-Dichloroethene (Total)	540-59-0	B		
1,2-Dichloropropane	78-87-5	H	WAC 173-340 B Carc	0.64
1,2-Dimethylhydrazine	540-73-8	H		
1,2-Diphenylhydrazine	122-66-7	H	WAC 173-340 B Carc	0.11
1,3,5-Trichlorobenzene	108-70-3	H		
1,3-Dichlorobenzene	541-73-1	B		
1,3-Dichloropropene	542-75-6	H	WAC 173-340 B Carc	0.24
1,4-Dichloro-2-butene	764-41-0	H		
1,4-Dichlorobenzene	106-46-7	B	WAC 173-340 B Carc	1.8
1,4-Dioxane	123-91-1	H	WAC 173-340 B Carc	4
1,4-Naphthoquinone	130-15-4	H		
1-Acetyl-2-thiourea	591-08-2	H		
1-Butanol	71-36-3	B	WAC 173-340 B Noncarc	1600
1-Butynol	L60	B		
1-Chloro-2,3-epoxypropane	106-89-8	H	WAC 173-340 B Carc	4.4
1-Naphthyl-2-thiourea	86-88-4	H		
1-Naphthylamine	134-32-7	B		
1-Phenol-1,2,-propanedione	579-07-7	P		
1-Propanol	71-23-8	H		
2-(2-methyl-4-chlorophenoxy) propionic acid	93-65-2	H	WAC 173-340 B Carc	16
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	B		
2,3,4,6-Tetrachlorophenol	58-90-2	B	WAC 173-340 B Noncarc	480
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	B		
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	B		
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	B	WAC 173-340 B Carc	5.8e-007
2,4,5-T(2,4,5-Trichlorophenoxyacetic acid)	93-76-5	H		
2,4,5-TP(2-(2,4,5-Trichlorophenoxy)propionic acid)Silvex	93-72-1	B	MCL	50
2,4,5-Trichlorophenol	95-95-4	B	WAC 173-340 B Noncarc	800
2,4,6-Trichlorophenol	88-06-2	B	WAC 173-340 B Carc	4

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
2,4-D(2,4-Dichlorophenoxyacetic acid)	94-75-7	B	MCL	70
2,4-DB(4-(2,4-Dichlorophenoxy)butanoic acid)	94-82-6	H		
2,4-Dichlorophenol	120-83-2	B	WAC 173-340 B Noncarc	24
2,4-Dimethylphenol	105-67-9	B	WAC 173-340 B Noncarc	160
2,4-Dinitrophenol	51-28-5	B	WAC 173-340 B Noncarc	32
2,4-Dinitrotoluene	121-14-2	B	WAC 173-340 B Noncarc	32
2,6-bis(1,1-Dimethyl)phenol	4130-42-1	P		
2,6-bis(1,1-dimethylethyl)-4-methyl phenol	128-37-0	P		
2,6-Dibromo-4-nitrophenol	99-28-5	P		
2,6-Dichlorophenol	87-65-0	B		
2,6-Dinitrotoluene	606-20-2	H	WAC 173-340 B Noncarc	16
2-Acetylaminofluorene	53-96-3	H		
2-Butanone	78-93-3	B	WAC 173-340 B Noncarc	4800
2-Chloroethyl vinyl ether	110-75-8	H		
2-Chloronaphthalene	91-58-7	H	WAC 173-340 B Noncarc	640
2-Chlorophenol	95-57-8	B	WAC 173-340 B Noncarc	40
2-Cyclohexyl-4,6-dinitrophenol	131-89-5	B		
2-Fluoro-4-nitrophenol	403-19-0	P		
2-Fluoro-6-nitrophenol	1526-17-6	P		
2-Heptanone	110-43-0	H		
2-Hexanone	591-78-6	B		
2-Methyl-2-(methylthio)propionaldehyde-o-(methylcarbonyl) ox	116-06-3	H	MCL	3
2-Methyl-4 chlorophenoxyacetic acid	94-74-6	H	WAC 173-340 B Noncarc	8
2-Methylaziridine	75-55-8	H		
2-Methyllactonitrile	75-86-5	H	WAC 173-340 B Noncarc	6.4
2-Methylnaphthalene	91-57-6	H	WAC 173-340 B Noncarc	32
2-Methylphenol (cresol, o-)	95-48-7	B	WAC 173-340 B Noncarc	400
2-Naphthylamine	91-59-8	B		
2-Nitroaniline	88-74-4	H		
2-Nitrophenol	88-75-5	B		
2-Nitrophenol-d4	93951-78-1	P		
2-Pentanone, 4-Methyl	108-10-1	B	WAC 173-340 B Noncarc	640
2-Picoline	109-06-8	H		
2-Propanol	67-63-0	B		
2-Propyn-1-ol	107-19-7	H	WAC 173-340 B Noncarc	16
3,3'-Dichlorobenzidine	91-94-1	H	WAC 173-340 B Carc	0.19

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
3,3'-Dimethoxybenzidine	119-90-4	H	WAC 173-340 B Carc	0.0095
3,3'-Dimethylbenzidine	119-93-7	H	WAC 173-340 B Carc	0.0095
3+4 Methylphenol (cresol, m+p)	65794-96-9	B		
3-Chloropropionitrile	542-76-7	H		
3-Ethylphenol	620-17-7	P		
3-Methylcholanthrene	56-49-5	H		
3-Methylphenol (cresol, m-)	108-39-4	B	WAC 173-340 B Carc	4.00E+02
3-Nitroaniline	99-09-2	H		
4,4'-DDD (Dichlorodiphenyldichloroethane)	72-54-8	B	WAC 173-340 B Carc	0.36
4,4'-DDE (Dichlorodiphenyldichloroethylene)	72-55-9	B	WAC 173-340 B Carc	0.26
4,4'-DDT (Dichlorodiphenyltrichloroethane)	50-29-3	B	WAC 173-340 B Carc	0.26
4,4'-Methylenebis(2-chloroaniline)	101-14-4	H		
4,6-Dinitro-2-methylphenol	534-52-1	B		
4-Aminobiphenyl	92-67-1	H		
4-Bromophenylphenyl ether	101-55-3	H		
4-Chloro-3-methylphenol	59-50-7	B		
4-Chloroaniline	106-47-8	H	WAC 173-340 B Noncarc	32
4-Chlorophenylphenyl ether	7005-72-3	H		
4-Methylphenol (cresol, p-)	106-44-5	B	WAC 173-340 B Noncarc	40
4-Nitroaniline	100-01-6	H		
4-Nitrophenol	100-02-7	B		
4-Nitroquinoline-1-oxide	56-57-5	H		
5-(Aminomethyl)-3-isoxazolol	2763-96-4	H		
5-Nitro-o-toluidine	99-55-8	H	WAC 173-340 B Carc	2.7
7,12-Dimethylbenz[a]anthracene	57-97-6	H		
7H-Dibenzo[c,g]carbazole	194-59-2	H		
Acenaphthene	83-32-9	H	WAC 173-340 B Noncarc	960
Acenaphthylene	208-96-8	H		
Acetone	67-64-1	B	WAC 173-340 B Noncarc	800
Acetonitrile	75-05-8	B		
Acetophenone	98-86-2	H	WAC 173-340 B Noncarc	800
Acrolein	107-02-8	H	WAC 173-340 B Noncarc	160
Acrylamide	79-06-1	H	WAC 173-340 B Carc	0.0097
Acrylonitrile	107-13-1	H	WAC 173-340 B Carc	0.081
Actinium-225	14265-85-1	P		
Actinium-227	14952-40-0	P		
Aldrin	309-00-2	B	WAC 173-340 B Carc	0.0026

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Alkalinity	ALKALINIT Y	H		
Allyl alcohol	107-18-6	H	WAC 173-340 B Noncarc	40
Allyl chloride	107-05-1	H		
Alpha	ALPHAHI	H		
alpha,alpha-Dimethylphenethylamine	122-09-8	H		
Alpha-BHC	319-84-6	B	WAC 173-340 B Carc	0.014
Alpha-Chlordane	5103-71-9	H		
Aluminum	7429-90-5	B	Bkgd_GW	200
Americium-241	14596-10-2	B	RDR/RAWP	1.2
Americium-242	13981-54-9	P		
Americium-242m	378252-98-3	P		
Americium-243	14993-75-0	P		
Amitrole	61-82-5	H		
Ammonia	7664-41-7	B		
Ammonium ion	14798-03-9	B	Bkgd_GW	120
Aniline	62-53-3	H	WAC 173-340 B Carc	7.7
Anthracene	120-12-7	H	WAC 173-340 B Noncarc	4800
Antimony	7440-36-0	B	MCL	6
Antimony-125	14234-35-6	B		
Antimony-126	15756-32-8	P		
Antimony-126m	378253-08-8	P		
Aramite	140-57-8	H		
Aroclor-1016	12674-11-2	B	WAC 173-340 B Noncarc	1.1
Aroclor-1221	11104-28-2	B		
Aroclor-1232	11141-16-5	B		
Aroclor-1242	53469-21-9	B		
Aroclor-1248	12672-29-6	B		
Aroclor-1254	11097-69-1	B	WAC 173-340 B Noncarc	0.32
Aroclor-1260	11096-82-5	B		
Aroclor-1262	37324-23-5	P		
Aroclor-1268	11100-14-4	P		
Arsenic	7440-38-2	B	Bkgd_GW	10
Arsenic, filtered	H37	H		
Astatine-217	17239-90-6	P		
Auramine	492-80-8	H		
Azobenzene	103-33-3	H	WAC 173-340 B Carc	0.8
Barium	7440-39-3	B	MCL	2000

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Barium-133	13981-41-4	H		
Barium-137m	378253-40-8	P		
Benz[c]acridine	225-51-4	H		
Benzene	71-43-2	B	WAC 173-340 B Carc	0.8
Benzenethiol	108-98-5	H	WAC 173-340 B Noncarc	0.08
Benzidine	92-87-5	H	WAC 173-340 B Carc	0.00038
Benzo(a)anthracene	56-55-3	B	WAC 173-340 B Carc	0.012
Benzo(a)pyrene	50-32-8	B	WAC 173-340 B Carc	0.012
Benzo(b)fluoranthene	205-99-2	B	WAC 173-340 B Carc	0.012
Benzo(ghi)perylene	191-24-2	H		
Benzo(k)fluoranthene	207-08-9	B	WAC 173-340 B Carc	0.012
Benzo[j]fluoranthene	205-82-3	H		
Benzoic acid	65-85-0	H	WAC 173-340 B Noncarc	64000
Benzothiazole	95-16-9	H		
Benzyl alcohol	100-51-6	H	WAC 173-340 B Noncarc	2400
Benzyl chloride	100-44-7	H	WAC 173-340 B Carc	0.26
Beryllium	7440-41-7	B	Bkgd_GW	<5
Beryllium-7	13966-02-4	B		
beta-1,2,3,4,5,6-Hexachlorocyclohexane (beta-BHC)	319-85-7	H	WAC 173-340 B Carc	0.049
Bis(2-chloro-1-methylethyl)ether	108-60-1	H	WAC 173-340 B Carc	0.63
Bis(2-Chloroethoxy)methane	111-91-1	H		
Bis(2-chloroethyl) ether	111-44-4	H	WAC 173-340 B Carc	0.04
Bis(2-ethylhexyl) phthalate	117-81-7	B	MCL	6
Bis(chloromethyl) ether	542-88-1	H	WAC 173-340 B Carc	0.0002
Bismuth	7440-69-9	P	Bkgd_GW	5
Bismuth-210	14331-79-4	P		
Bismuth-211	15229-37-5	P		
Bismuth-212	14913-49-6	P		
Bismuth-213	15776-20-2	P		
Bismuth-214	14733-03-0	P		
Bisphenol A	80-05-7	P		
Boron	7440-42-8	B	WAC 173-340 B Noncarc	3200
Bromide	24959-67-9	B		
Bromoacetone	598-31-2	H		
Bromodichloromethane	75-27-4	B	WAC 173-340 B Carc	0.71
Bromoform	75-25-2	H	WAC 173-340 B Carc	5.5
Bromomethane	74-83-9	H	WAC 173-340 B Noncarc	11

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Butylbenzylphthalate	85-68-7	H	WAC 173-340 B Noncarc	3200
Cadmium	7440-43-9	B	Bkgd_GW	<10
Calcium	7440-70-2	H	Bkgd_GW	63600
Carbazole	86-74-8	H		
Carbon disulfide	75-15-0	B	WAC 173-340 B Noncarc	800
Carbon tetrachloride	56-23-5	B	WAC 173-340 B Carc	0.34
Carbon-14	14762-75-5	B	RDR/RAWP	2000
Carbon-14 percent modern carbon	C14 PMC	H		
Carbonate ion	3812-32-6	P		
Carbophenothion	786-19-6	H	WAC 173-340 B Noncarc	2.1
Cerium	7440-45-1	P		
Cerium/Praseodymium-144	CE/PR-144	B		
Cesium-134	13967-70-9	B		
Cesium-135	15726-30-4	P		
Cesium-137	10045-97-3	B	RDR/RAWP	60
Chemical Oxygen Demand	COD	H		
Chlordane	57-74-9	H	WAC 173-340 B Carc	0.25
Chloride	16887-00-6	B	Bkgd_GW	8690
Chlorine-36	13981-43-6	P		
Chlornaphazine	494-03-1	H		
Chloroacetaldehyde	107-20-0	H		
Chloroalkyl ethers	B44	H		
Chlorobenzene	108-90-7	B	MCL	100
Chlorobenzilate	510-15-6	H	WAC 173-340 B Carc	0.32
Chloroethane	75-00-3	H	WAC 173-340 B Carc	15
Chloroform	67-66-3	B	WAC 173-340 B Carc	7.2
Chloromethane	74-87-3	B	WAC 173-340 B Noncarc	5.8
Chloromethyl methyl ether	107-30-2	H		
Chloroprene	126-99-8	H	WAC 173-340 B Noncarc	160
Chromium	7440-47-3	B	MCL	100
Chromium-51	14392-02-0	H		
Chrysene	218-01-9	B	WAC 173-340 B Carc	0.012
cis-1,2-Dichloroethylene	156-59-2	B	MCL	70
cis-1,3-Dichloropropene	10061-01-5	H		
Citrate	126-44-3	P		
Citrus red No. 2	6358-53-8	H		
Cobalt	7440-48-4	B		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Cobalt-58	13981-38-9	B		
Cobalt-60	10198-40-0	B	RDR/RAWP	100
Coliform Bacteria	COLIFORM	H		
Copper	7440-50-8	B	WAC 173-340 B Noncarc	590
Crotonaldehyde	4170-30-3	H	WAC 173-340 B Carc	0.023
Curium-242	15510-73-3	P		
Curium-244	13981-15-2	P		
Curium-245	15621-76-8	P		
Cyanide	57-12-5	B	MCL	200
Cyclohexane	110-82-7	P		
Cyclohexanone	108-94-1	P	WAC 173-340 B Noncarc	40000
Dalapon	75-99-0	H	MCL	200
Decane	124-18-5	B		
delta Carbon-13 ratio relative to PDB (Pee Dee Belemnite)	DELTA-C13	H		
delta Deuterium ratio relative to SMOW	DELTA-H2	H		
delta Oxygen-18 ratio relative to SMOW	DELTA-O18	H		
delta Sulfur-34 ratio relative to Canyon Diablo troilite	DELTA-S34	H		
Delta-BHC	319-86-8	B		
Diallate	2303-16-4	H	WAC 173-340 B Carc	1.4
Dibenz[a,h]acridine	226-36-8	H		
Dibenz[a,h]anthracene	53-70-3	B	WAC 173-340 B Carc	0.012
Dibenz[a,j]acridine	224-42-0	H		
Dibenzo[a,e]pyrene	192-65-4	H		
Dibenzo[a,h]pyrene	189-64-0	H		
Dibenzo[a,i]pyrene	189-55-9	H		
Dibenzofuran	132-64-9	H	WAC 173-340 B Noncarc	32
Dibromochloromethane	124-48-1	B	WAC 173-340 B Carc	0.52
Dibromomethane	74-95-3	H	WAC 173-340 B Noncarc	80
Dibutyl Butylphosphonate	78-46-6	P		
Dibutylphosphate	107-66-4	B		
Dicamba	1918-00-9	H	WAC 173-340 B Noncarc	480
Dichlorodifluoromethane	75-71-8	H	WAC 173-340 B Noncarc	1600
Dichloromethyl-benzene	98-87-3	H		
Dichloroprop	120-36-5	H		
Dieldrin	60-57-1	B	WAC 173-340 B Carc	0.0055
Diethyl arsine	692-42-2	H		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Diethyl ether	60-29-7	B	WAC 173-340 B Noncarc	1600
Diethylphthalate	84-66-2	B	WAC 173-340 B Noncarc	13000
Diethylstilbesterol	56-53-1	H		
Dihydrosafrole	94-58-6	H		
Dimethoate	60-51-5	B	WAC 173-340 B Noncarc	3.2
Dimethyl phthalate	131-11-3	H	WAC 173-340 B Noncarc	16000
Di-n-butylphthalate	84-74-2	B	WAC 173-340 B Noncarc	1600
Di-n-octylphthalate	117-84-0	H	WAC 173-340 B Noncarc	320
Dinoseb(2-secButyl-4,6-dinitrophenol)	88-85-7	B	MCL	7
Diphenylamine	122-39-4	H	WAC 173-340 B Noncarc	400
Dissolved oxygen	DO	H		
Disulfoton	298-04-4	H	WAC 173-340 B Noncarc	0.64
Dodecane	112-40-3	H		
EDTA	60-00-4	P		
Endosulfan I	959-98-8	H		
Endosulfan II	33213-65-9	H		
Endosulfan sulfate	1031-07-8	B		
Endrin	72-20-8	B	MCL	2
Endrin aldehyde	7421-93-4	B		
Endrin ketone	53494-70-5	H		
Ethanol	64-17-5	B		
Ethyl acetate	141-78-6	H	WAC 173-340 B Noncarc	7200
Ethyl carbamate (Urethane)	51-79-6	H		
Ethyl cyanide	107-12-0	B		
Ethyl methacrylate	97-63-2	H	WAC 173-340 B Noncarc	720
Ethyl methanesulfonate	62-50-0	H		
Ethylbenzene	100-41-4	B	MCL	700
Ethylene glycol	107-21-1	B	WAC 173-340 B Noncarc	16000
Ethylene oxide	75-21-8	H	WAC 173-340 B Carc	0.043
Ethyleneimine	151-56-4	H		
Ethylenethiourea	96-45-7	H		
Europium-152	14683-23-9	B	RDR/RAWP	200
Europium-154	15585-10-1	B	RDR/RAWP	60
Europium-155	14391-16-3	B	RDR/RAWP	600
Famphur	52-85-7	H		
Ferrocyanide	13408-63-4	P		
Fluoranthene	206-44-0	H	WAC 173-340 B Noncarc	640

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Fluorene	86-73-7	H	WAC 173-340 B Noncarc	640
Fluoride	16984-48-8	B	WAC 173-340 B Noncarc	960
Formaldehyde	50-00-0	B	WAC 173-340 B Noncarc	1200
Francium-221	15756-41-9	P		
Francium-223	15756-98-6	P		
Free Cyanide	FREE-CN	P		
Gamma-BHC (Lindane)	58-89-9	B	WAC 173-340 B Carc	0.067
Gamma-Chlordane	5103-74-2	H		
Gold	7440-57-5	P		
Gross alpha	12587-46-1	B	MCL	15
Gross beta	12587-47-2	B		
Hardness	HARDNESS	H		
HEDTA	150-39-0	P		
Heptachlor	76-44-8	B	WAC 173-340 B Carc	0.019
Heptachlor epoxide	1024-57-3	B	WAC 173-340 B Carc	0.0048
Heptachlorodibenzofurans	38998-75-3	B		
Heptachlorodibenzo-p-dioxins	37871-00-4	B		
Hexachlorobenzene	118-74-1	H	WAC 173-340 B Carc	0.055
Hexachlorobutadiene	87-68-3	H	WAC 173-340 B Carc	0.56
Hexachlorocyclopentadiene	77-47-4	H	WAC 173-340 B Noncarc	48
Hexachlorodibenzofurans	55684-94-1	B		
Hexachlorodibenzo-p-dioxin	34465-46-8	B		
Hexachloroethane	67-72-1	H	WAC 173-340 B Carc	3.1
Hexachlorophene	70-30-4	H		
Hexachloropropene	1888-71-7	H		
Hexane	110-54-3	P	WAC 173-340 B Noncarc	480
Hexavalent Chromium	18540-29-9	B	WAC 173-340 B Noncarc	48
Hydrazine	302-01-2	B	WAC 173-340 B Carc	0.015
Hydrofluoric acid	7664-39-3	P		
Hydrogen sulfide	7783-06-4	H	WAC 173-340 B Noncarc	24
Hydroxide	14280-30-9	P		
Hydroxyacetic acid	79-14-1	P		
Indeno(1,2,3-cd)pyrene	193-39-5	B	WAC 173-340 B Carc	0.012
Iodine-129	15046-84-1	B	RDR/RAWP	1
Iodine-131	10043-66-0	P		
Iodomethane	74-88-4	H		
Iron	7439-89-6	B	Bkgd_GW	818

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Iron-59	14596-12-4	H		
Isobutyl alcohol	78-83-1	H	WAC 173-340 B Noncarc	2400
Isodrin	465-73-6	H		
Isophorone	78-59-1	H	WAC 173-340 B Carc	46
Isosafrole	120-58-1	H		
Kepone	143-50-0	H		
Lanthanum	7439-91-0	P		
Lanthanum hydroxide	14507-19-8	P		
Lead	7439-92-1	B	MCL	15
Lead-209	14119-30-3	P		
Lead-210	14255-04-0	P		
Lead-211	15816-77-0	P		
Lead-212	15092-94-1	B		
Lead-214	15067-28-4	P		
Lithium	7439-93-2	B		
Magnesium	7439-95-4	B	Bkgd_GW	16480
Maleic hydrazide	123-33-1	H		
Malononitrile	109-77-3	H	WAC 173-340 B Noncarc	0.16
Manganese	7439-96-5	B	WAC 173-340 B Noncarc	2200
Manganese-54	13966-31-9	P		
m-Dinitrobenzene	99-65-0	H		
Melphalan	148-82-3	H		
Mercury	7439-97-6	B	MCL	2
Methacrylonitrile	126-98-7	H	WAC 173-340 B Noncarc	0.8
Methanethiol	74-93-1	H		
Methanol	67-56-1	H	WAC 173-340 B Noncarc	4000
Methapyrilene	91-80-5	H		
Metholonyl	16752-77-5	H		
Methoxychlor	72-43-5	B	MCL	40
Methyl methacrylate	80-62-6	H	WAC 173-340 B Noncarc	11000
Methyl methanesulfonate	66-27-3	H		
Methyl parathion	298-00-0	H	WAC 173-340 B Noncarc	4
Methylene chloride	75-09-2	B	MCL	5
Methylthiouracil	56-04-2	H		
Molybdenum	7439-98-7	B	WAC 173-340 B Noncarc	80
Monobutyl phosphate	1623-15-0	B		
m+p-Xylene	1330-20-7	H		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
m-Xylene	108-38-3	H	WAC 173-340 B Noncarc	16000
n,n-Diethylhydrazine	616-40-0	H		
Naphthalene	91-20-3	B	WAC 173-340 B Noncarc	160
n-Butylbenzene	104-51-8	P		
Neptunium-237	13994-20-2	P	RDR/RAWP	15
Neptunium-239	13968-59-7	P		
Nickel	7440-02-0	B	WAC 173-340 B Noncarc	320
Nickel-63	13981-37-8	B		
Nickel-64	EQM_Ni64	P		
Nicotinic acid	59-67-6	H		
Nitrate	14797-55-8	B	MCL	44285
Nitrite	14797-65-0	B	MCL	3286
Nitrobenzene	98-95-3	H	WAC 173-340 B Noncarc	4
Nitrogen in Nitrite and Nitrate	NO2+NO3-N	H		
Nitrosopyrrolidine	930-55-2	H	WAC 173-340 B Carc	0.021
n-Nitrosodiethanolamine	1116-54-7	H		
n-Nitrosodiethylamine	55-18-5	H	WAC 173-340 B Carc	0.00029
n-Nitrosodimethylamine	62-75-9	H	WAC 173-340 B Carc	0.00086
n-Nitrosodi-n-butylamine	924-16-3	H	WAC 173-340 B Carc	0.0081
n-Nitrosodi-n-dipropylamine	621-64-7	H		
n-Nitrosodiphenylamine	86-30-6	B		
n-Nitrosomethylethylamine	10595-95-6	H		
n-Nitrosomethylvinylamine	4549-40-0	H		
n-Nitrosomorpholine	59-89-2	H		
n-Nitroso-N-methylurethane	615-53-2	H		
n-Nitrosonornicotine	16543-55-8	H		
n-Nitrosopiperidine	100-75-4	H		
n-Phenylthiourea	103-85-5	H		
n-Propylamine	107-10-8	H		
O,O,O-Triethyl phosphorothioate	126-68-1	H		
O,O-Diethyl O-2-pyrazinyl phosphorothioate	297-97-2	H		
o,p-Xylene	OPXYLENE	H		
Octachlorodibenzofuran	39001-02-0	B		
Octachlorodibenzo-p-dioxin	3268-87-9	B		
Octathiocane	10544-50-0	H		
Oil and grease	OIL/GREASE	B		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
o-Toluidine	95-53-4	H	WAC 173-340 B Carc	0.18
o-Toluidine hydrochloride	636-21-5	H	WAC 173-340 B Carc	0.49
Oxalate	EQM_OXALATE	P		
Oxidation Reduction Potential	EH	H		
o-Xylene	95-47-6	H	WAC 173-340 B Noncarc	16000
Palladium-107	17637-99-9	P		
Paraldehyde	123-63-7	H		
Parathion	56-38-2	H	WAC 173-340 B Noncarc	96
p-Benzoquinone	106-51-4	H		
p-Dimethylaminoazobenzene	60-11-7	H		
Pentachlorobenzene	608-93-5	H	WAC 173-340 B Noncarc	13
Pentachlorodibenzofurans	30402-15-4	B		
Pentachlorodibenzo-p-dioxins	36088-22-9	B		
Pentachloroethane	76-01-7	H		
Pentachloronitrobenzene (PCNB)	82-68-8	H	WAC 173-340 B Carc	0.34
Pentachlorophenol	87-86-5	B	WAC 173-340 B Carc	0.73
Pentadecane	629-62-9	H		
Perchlorate anion	14797-73-0	B	WAC 173-340 B Noncarc	11
Periodic acid	10450-60-9	P		
Peroxide ion	EQM_PEROX	P		
pH Measurement	PH	H		
Phenacetin	62-44-2	H		
Phenanthrene	85-01-8	H		
Phenol	108-95-2	B	WAC 173-340 B Noncarc	4800
Phenol-d6	13127-88-3	P		
Phenolphthalein	77-09-8	P		
Phenylenediamine	25265-76-3	H		
Phorate	298-02-2	B	WAC 173-340 B Noncarc	3.2
Phosphate	14265-44-2	B	Bkgd_GW	1000
Phosphorus	7723-14-0	B	WAC 173-340 B Noncarc	0.16
Phthalic acid esters	C31	H		
Plutonium-238	13981-16-3	B	RDR/RAWP	1.6
Plutonium-239	15117-48-3	H		
Plutonium-239/240	PU-239/240	B	RDR/RAWP	1.2
Plutonium-241	14119-32-5	B		
Polonium-210	13981-52-7	P		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Polonium-213	15756-57-7	P		
Polonium-214	15735-67-8	P		
Polonium-215	15706-52-2	P		
Polonium-218	15422-74-9	P		
Polychlorinated biphenyls, total	1336-36-3	P	WAC 173-340 B Carc	0.044
Polychlorinated dibenzofurans	136677-10-6	B		
Polychlorinated dibenzo-p-dioxins	136677-09-3	B		
Potassium	7440-09-7	B	Bkgd_GW	7975
Potassium-40	13966-00-2	B		
p-Phenylenediamine	106-50-3	H	WAC 173-340 B Noncarc	3000
Promethium-147	1430-75-7	P		
Pronamide	23950-58-5	H	WAC 173-340 B Noncarc	1200
Protactinium-231	14331-85-2	P		
Protactinium-233	13981-14-1	P		
Protactinium-234	15100-28-4	P		
Protactinium-234m	378783-76-7	P		
p-Xylene	106-42-3	H		
Pyrene	129-00-0	B	WAC 173-340 B Noncarc	480
Pyridine	110-86-1	H	WAC 173-340 B Noncarc	8
Radium	7440-14-4	H		
Radium-223	15623-45-7	P		
Radium-224	13233-32-4	P		
Radium-225	13981-53-8	P		
Radium-226	13982-63-3	B		
Radium-228	15262-20-1	B		
Radon-220	22481-48-7	P		
Radon-222	14859-67-7	P		
Reserpine	50-55-5	H		
Resorcinol	108-46-3	H		
Rhodium-106	14234-34-5	P		
Ruthenium-101	EQM_RU-101	P		
Ruthenium-103	13968-53-1	B		
Ruthenium-106	13967-48-1	B		
Safrol	94-59-7	H		
Samarium-151	15715-94-3	P		
Selenium	7782-49-2	B	MCL	50
Selenium-79	15758-45-9	P		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Silicon	7440-21-3	B	Bkgd_GW	26500
Silver	7440-22-4	B	WAC 173-340 B Noncarc	80
Sodium	7440-23-5	B	Bkgd_GW	33500
Specific Conductance	CONDUCT	H		
Strontium	7440-24-6	B	WAC 173-340 B Noncarc	9600
Strontium-90	10098-97-2	B	RDR/RAWP	8
Strychnine	57-24-9	H	WAC 173-340 B Noncarc	4.8
Styrene	100-42-5	B	WAC 173-340 B Carc	1.5
Sucrose	57-50-1	P		
Sulfamate	EQM_SULF AMATE	P		
Sulfate	14808-79-8	B	Bkgd_GW	90500
Sulfide	18496-25-8	B		
Sulfur	7704-34-9	P		
sym-Trinitrobenzene	99-35-4	H	WAC 173-340 B Noncarc	43000
Tartaric acid	526-83-0	P		
Technetium-99	14133-76-7	B	RDR/RAWP	900
Temperature	TEMPERAT URE	H		
Tetrachlorodibenzofurans	55722-27-5	B		
Tetrachlorodibenzo-p-dioxins	41903-57-5	B		
Tetrachloroethene	127-18-4	B	WAC 173-340 B Carc	0.081
Tetrachlorophenol	25167-83-3	B	WAC 173-340 B Noncarc	480
Tetradecane	629-59-4	H		
Tetraethyl dithiopyrophosphate (Sulfotepp)	3689-24-5	H	WAC 173-340 B Noncarc	8
Tetraethylpyrophosphate	107-49-3	H		
Tetrahydrofuran	109-99-9	B		
Thallium	7440-28-0	B	WAC 173-340 B Noncarc	1.1
Thallium-207	14133-67-6	P		
Thallium-208	14913-50-9	P		
Thenoyltrifluoroacetone	326-91-0	P		
Thiocyanate	303-04-5	P		
Thiofanox	39196-18-4	H	WAC 173-340 B Noncarc	4.8
Thiourea	62-56-6	H		
Thiuram	137-26-8	H		
Thorium	7440-29-1	H		
Thorium-227	15623-47-9	P		
Thorium-228	14274-82-9	H		

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Thorium-229	15594-54-4	P		
Thorium-230	14269-63-7	P		
Thorium-231	14932-40-2	P		
Thorium-232	TH-232	B		
Thorium-233	EQM_TH-233	P		
Thorium-234	15065-10-8	P		
Tin	7440-31-5	B	WAC 173-340 B Noncarc	9600
Tin-113	13966-06-8	P		
Tin-126	15832-50-5	P		
Titanium	7440-32-6	B		
Toluene	108-88-3	B	WAC 173-340 B Noncarc	640
Toluenediamine	25376-45-8	H		
Total beta radiostrontium	SR-RAD	H		
Total carbon	TC	H		
Total cresols	1319-77-3	H		
Total dissolved solids	TDS	H		
Total halogens (all)	TOTHALOGEN	H		
Total Inorganic Carbon	TINC	B		
Total organic carbon	TOC	H		
Total organic halides	59473-04-0	H		
Total petroleum hydrocarbons	TPH	H	WAC 173-340	1,000,000
Total petroleum hydrocarbons - diesel range	TPHDIESEL	B	WAC 173-340	1,000,000
Total petroleum hydrocarbons - gasoline range	TPHGASOLINE	H	WAC 173-340	1,000,000
Total petroleum hydrocarbons - kerosene range	TPHKEROSENE	B	WAC 173-340	2,000,000
Total suspended solids	TSS	H		
Total Trihalomethanes	THM	H		
Toxaphene	8001-35-2	B	WAC 173-340 B Carc	0.08
trans-1,2-Dichloroethylene	156-60-5	B	MCL	100
trans-1,3-Dichloropropene	10061-02-6	H		
trans-1,4-Dichloro-2-butene	110-57-6	H		
Tributyl phosphate	126-73-8	B		
Trichloroethene	79-01-6	B	WAC 173-340 B Carc	0.11
Trichloromethanethiol	75-70-7	H		
Trichloromonofluoromethane	75-69-4	B	WAC 173-340 B Noncarc	2400

Table E1-1. Analytes and Selected Preliminary Remediation Goals. (17 Pages)

Analyte Name	Analyte ID	Source[a]	PRG[b]	Value[c]
Trichlorophenol	25167-82-2	B	WAC 173-340 B Noncarc	800
Trichloropropane	25735-29-9	H		
Tridecane	629-50-5	H		
Tri-n-dodecylamine	102-87-4	P		
Tris(2,3-dibromopropyl) phosphate	126-72-7	H		
Tris-2-chloroethyl phosphate	115-96-8	B		
Tritium	10028-17-8	B	MCL	20000
Tungsten	7440-33-7	P		
Turbidity	TURBIDITY	H		
Unknown	I99	H		
Unknown halogenated hydrocarbon	UNKHALHY DC	H		
Uranium	7440-61-1	B	MCL	30
Uranium-233/234	U-233/234	B	RDR/RAWP	20
Uranium-234	13966-29-5	B	RDR/RAWP	20
Uranium-235	15117-96-1	B	RDR/RAWP	20
Uranium-236	13982-70-2	H		
Uranium-238	U-238	B	RDR/RAWP:	20
Vanadium	7440-62-2	B	WAC 173-340 B Noncarc	110
Vinyl acetate	108-05-4	H	WAC 173-340 B Noncarc	8000
Vinyl chloride	75-01-4	B	WAC 173-340 B Carc	0.029
Warfarin	81-81-2	H	WAC 173-340 B Noncarc	2.4
Xylenes (total)	1330-20-7	B	MCL	10000
Yttrium-90	10098-91-6	P		
Zinc	7440-66-6	B	WAC 173-340 B Noncarc	4800
Zinc-65	13982-39-3	B		
Zirconium	7440-67-7	B		
Zirconium/Niobium-95	ZR/NB-95	B		
Zirconium-93	15751-77-6	P		

[a] in the source column, "P" shows the constituents that were located in historical process documents; "H" shows those in the *Hanford Environmental Information System*, Hanford Site database; and "B" shows those that are in both.

[b] The PRGs are preliminary remediation goals based on MCLs (maximum contaminant levels) from the Washington State Department of Ecology and the U.S. Environmental Protection Agency. The WAC 173-340 B Noncarc = Cleanup levels for groundwater as determined by the WAC 173-340, Model Toxics Control Act -- Cleanup," Method B standard formula for noncarcinogenic risks. WAC 173-340 B Carc = Cleanup levels for groundwater as determined by the WAC 173-340 Method B standard formula for carcinogenic risks. Bkgd_GW = The groundwater background threshold value, as listed in DOE/RL-92-23, *Hanford Site Groundwater Background*, Table 5-9. The RDR/RAWP are values defined in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area.*

[c] Values are in picocuries per liter for radiological constituents and micrograms per liter for nonradiological constituents.

E1.1 EVALUATION OF CONTAMINANTS OF POTENTIAL CONCERN: CONTAMINANTS OF POTENTIAL CONCERN INCLUSION/EXCLUSION PROCESS

The following logic was used for the nonradiological COPCs evaluation.

- If the compound/element/anion was listed, it was examined in the *CLARC Database* (Ecology 2005), the *Integrated Risk Information System* (IRIS) database (maintained by the EPA) and the *Agency for Toxic Substances and Disease Registry* (ATSDR) database to list both carcinogenic and toxic constituents. If the IRIS database indicated that it was neither carcinogenic nor toxic, then it was not included as a COPC.

- Parameters that are not specific compounds and that provide no specific risk information (e.g., pH or total organic carbon) were excluded from the formal *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) COPC list. However, in some cases, these analyses will be performed on selected wells to assist in modeling.

- If the constituent has a PRG from the following criteria, it was included in the formal evaluation:

  - The primary or secondary MCL for drinking water specified by the EPA.

  - The cleanup levels for groundwater as determined by the WAC 173-340-720(4), "Method B Cleanup Levels for Potable Ground Water," standard formula for noncarcinogenic risks.

  - The cleanup levels for groundwater as determined by the WAC173-340-720(4) standard formula for carcinogenic risks.

  - The groundwater background threshold value, as listed in DOE/RL-92-23, Table 5-9, and the PRGs as defined in DOE/RL-96-17.

E1.2 SELECTION LOGIC FOR RADIOLOGICAL AND NONRADIOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

In addition to the previous evaluation criteria, any radionuclide with a half-life of less than 2 years was not included. Similarly, natural short-lived daughter products of radionuclides in the list were discarded, because the daughters are considered in any calculation of dose from the parent isotopes.

Additional screening included the following:

- Evaluation of detects versus nondetects over time
- Evaluation of detects versus PRGs.

An initial data download was taken from HEIS on 11/01/06, which included well data from 1988 to 2006, and was compiled into a Microsoft Access[1] database. The data were developed into comprehensive target tables, which are described in detail below. The following text describes the evaluation steps used in Figure E1-1. The diagram presents the logic used in the evaluation of the COPCs in the Microsoft Access database (COPC database[2]).

1. "ND" in the COPC database indicates that no data were found in the database for a particular well and contaminant.

2. For all wells, the last year the well was sampled is noted in the COPC database as a year. For example if a well was last sampled in 1998, then the number "1998" appears in the COPC database.

3. If only one or two data points were found for a particular contaminant, then "1DP" or "2DP" is indicated in the COPC database.

4. If fewer than two results exceeded the regulatory limits within the past 10 years, then a "-" is indicated in the COPC database (includes the value of zero or none).

5. If the database results for any contaminant were greater than the PRG, but the laboratory put a "U" qualifier next to the result, the "U" qualifier indicates that the result is considered a nondetect by the laboratory.

6. If two or more results for any individual contaminant were greater than the PRG, and those results occurred in the last 10 years, then a "+" was placed in the COPC database for that well. This indicates that the contaminant should be added to the final list of COPCs.

The output from the evaluation process (COPC database) is available electronically on request. Each constituent presented in the COPC database was evaluated by comparing the number of detects that exceeded the PRGs. Any constituent that had one exceedance was evaluated further by querying the original database. A query was performed to determine the exact date of the exceedances(s) and the particular well(s) that the exceedances(s) occurred in. If it was determined that subsequent analyses from the same well(s) returned results that were consistently below the PRGs, the constituent(s) was removed from the COPC list; otherwise, the contaminant remained on the proposed list of COPCs.

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[1] Access is a trademark of Microsoft Corporation, Redmond, Washington.

[2] The COPC database used for this evaluation is available electronically on request.

Figure E1-1. Data Evaluation Flow Diagram for Assigning 200-PO-1 Groundwater Operable Unit Contaminants of Potential Concern.

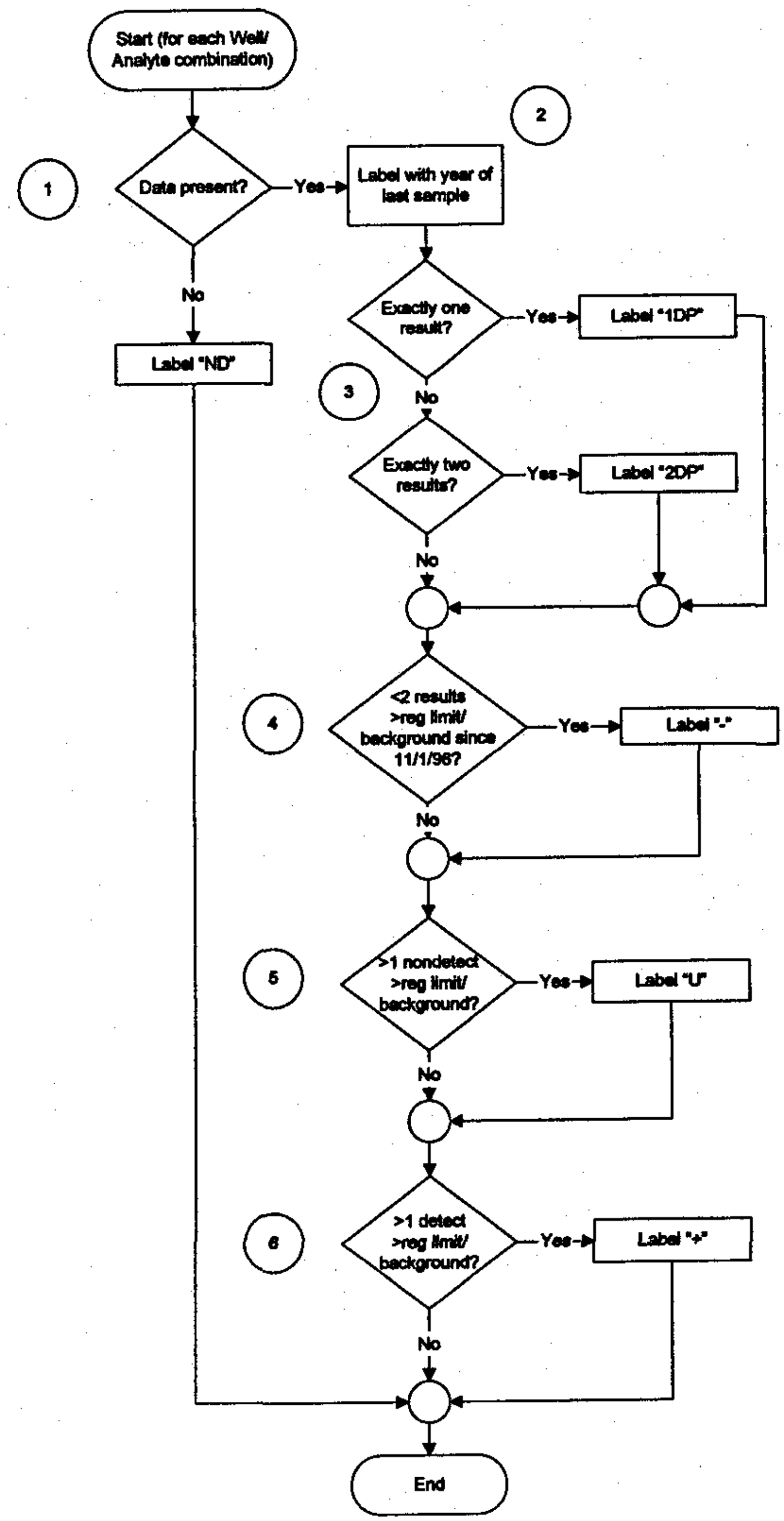

Table E1-2 presents the proposed list of COPCs for the 200-PO-1 Groundwater OU. Tables E1-3 and E1-4 present all of the nonradiological and radiological COPCs, respectively, that were located in historic process documents, and the justifications for their inclusion or exclusion as a COPC.

Table E1-2. Proposed List of Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit.

Metals	Semivolatile Organic Compounds
Antimony	2,4-Dinitrophenol
Arsenic	Bis (2-ethylhexyl) phthalate
Cadmium	Nitrobenzene[b]
Chromium	Pentachlorophenol
Lead	**Radiological**
Manganese	Gross alpha
Nickel	Iodine-129
Thallium	Neptunium-237[a]
Uranium	Protactinium-231[a]
Vanadium	Selenium-79[a]
Zinc	Strontium-90
Volatile Organic Compounds	Technetium-99
1,1,2,2-Tetrachloroethane	Tritium
1,2-Dichloroethane	Uranium-234
1,4-Dioxane[b]	Uranium-238
Benzene	**Pesticides**
Bromodichloromethane	Dieldrin
Carbon tetrachloride	Dimethoate
Dibromochloromethane	Heptachlor
Hexane[a]	Heptachlor epoxide
Methylene chloride	**Ions**
Tetrachloroethene	Fluoride
Trichloroethene	Nitrate
Vinyl chloride	Nitrite

[a] Represents constituents found in historical process documents that have a potential to contribute to dose and have long half lives, or in the case of hexane, regulatory limits set because of the U.S. Environmental Protection Agency listing as a possible carcinogen; these contaminants of potential concern have not been analyzed in the 200-PO-1 OU.

[b] Represents constituents not found in historical process documents, but is found in the 200-PO-1 Groundwater Operable Unit.

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Metal Contaminants of Potential Concerns										
Aluminum	x				N	Last analyzed for in 2006; from 1988 to present 3453 results from 160 wells; no PRGs; no data in IRIS	x	x	x	
Aluminum nitrate monobasic	x				N	See aluminum and nitrate				
Aluminum nitrate nonahydrate	x				N	See aluminum and nitrate	x			
Antimony					Y	Last analyzed for in 2006; from 1988 to present 4255 results from 162 wells: 42 detects and 3912 non-detects exceed PRGs; within the last 10 years 112 wells had more than one exceedance	x	x	x	
Arsenic	x		x	x	Y	Last analyzed for in 2006; from 1988 to present 2147 results from 101 wells: 236 detects and 11 non-detects exceed PRGs and background; within the last 10 years 8 wells had more than one exceedance	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Barium	x				N	Last analyzed for in 2006; from 1988 to present 4372 results from 169 wells: one detect and zero non-detects exceed PRGs, subsequent results in well with exceedance below limits	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Beryllium	x				N	Last analyzed for in 2006; from 1988 to present 4257 results from 162 wells: 6 detects and 41 non-detects exceed PRGs and background; but subsequent sampling in wells with exceeds all below limits	x	x	x	
Bismuth	x				N	Not analyzed for in PO-1 groundwater; not a known carcinogen; no PRGs available	x	x		
Bismuth phosphate	x	x			N	Quantities listed : 130,000 kg in 216-A-8 crib; see bismuth and phosphate				
Boron	x				N	Last analyzed for in 1995; from 1988 to present 519 results from 92 wells: zero detects and zero non-detects exceed PRGs		x	x	
Cadmium	x				Y	Last analyzed for in 2006; from 1988 to present 4415 results from 162 wells: 6 detects and zero non-detects exceed PRGs and background;	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Cadmium nitrate	x				N	See cadmium and nitrate	x			
Ceric fluoride	x				N	See cerium and fluoride				
Ceric sulfate	x				N	See cerium and sulfate				
Cerium	x				N	Not analyzed for in PO-1 groundwater; no PRGs available; no data in IRIS				
Chromium	x		x	x	Y	Last analyzed for in 2006; from 1988 to present 4424 results from 162 wells: 173 detects and zero non-detects exceed PRGs	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Cobalt					N	Last analyzed for in 2006; from 1988 to present 4012 results from 160 wells; no PRGs available; no data in IRIS; radioactive component considered under radionuclides		x	x	
Copper	x				N	Last analyzed for in 2006; from 1988 to present 4255 results from 162 wells: zero detects and zero non-detects exceed PRGs; not a known human carcinogen (IRIS);	x	x	x	
Ferric nitrate	x				N	See iron and nitrate				
Ferrocyanide	x	x			N	See Iron and cyanide		x		
Ferrous sulfamate	x				N	See iron and sulfate	x			
Ferrous sulfate	x				N	See iron and sulfate				

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Gold	x				N	Not analyzed for in PO-1 groundwater; No PRG available; no data in IRIS				
Hexavalent chromium				x	N	Last analyzed for in 1997; from 1988 to 1997 6 results from 6 wells: zero detects and zero non-detects exceed PRGs;	x		x	
Iron	x				N	Last analyzed for in 2006; from 1988 to present 4342 results from 168 wells; Iron poses no risk but may be important for remedial action alternative evaluation		x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Lanthanum	x				N	Not analyzed for in PO-1 groundwater; No toxicity or carcinogen data available in EPA databases; tightly bound to soil		x		
Lanthanum fluoride	x				N	See lanthanum and fluoride				
Lanthanum hydroxide	x				N	See lanthanum and hydroxide				
Lanthanum nitrate	x				N	See lanthanum and nitrate				
Lead	x			x	Y	Last analyzed for in 2006; from 1988 to present 1968 results from 109 wells: 13 detects and 17 non-detects exceed PRGs; 2 wells within the last 10 years had exceedances;	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3
Lead nitrate	x				N	See lead and nitrate				
Lithium					N	Last analyzed for in 1999; from 1988 to 1999 492 results from 65 wells; no PRGs available; no data in IRIS	x	x	x	
Magnesium	x				N	Last analyzed for in 2006; from 1988 to present 4375 results from 169 wells: No PRGs available		x	x	
Manganese	x		x	x	Y	Last analyzed for in 2006; from 1988 to present 4298 results from 164 wells: 5 detects and zero non-detects exceed PRGs	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Mercury	x			x	N	Last analyzed for in 2006; from 1988 to present 1787 results from 102 wells: zero detects and zero non-detects exceed PRGs;	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3
Mercuric nitrate	x				N	See mercury and nitrate				
Molybdenum					N	Last analyzed for in 1999; from 1988 to 1999 501 results from 66 wells; zero detects and zero non-detects exceed PRGs	x			
Nickel	x				Y	Last analyzed for in 2006; 4267 results from 162 wells: 4 detects and zero non-detects exceed PRGs; within the last 10 years one well had more than one exceedance;	x	x	x	
Nickel nitrate	x				N	See nickel and nitrate				
Potassium	x	x			N	Last analyzed for in 2006; from 1988 to present 4359 results from 169 wells; No health risk; radioactive component covered with radioactive constituents		x	x	
Potassium fluoride	x				N	See potassium and fluoride				
Potassium hydroxide	x				N	See potassium and hydroxide	x			
Potassium oxalate	x				N	See potassium and oxalate				
Potassium permanganate	x				N	See potassium and manganese	x			
Radium					N	Last analyzed for in 2005; from 1988 to 2005 589 results from 72 wells; no PRGs available; Will be considered as its radiological part; no data in IRIS;			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Selenium	x				N	Last analyzed for in 2006; from 1988 to present 1792 results from 101 wells: zero detects and 11 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but exceedances were non-detect;	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Selenium tetroxide	x				N	See selenium				
Silicon	x				N	Last analyzed for in 2006; from 1988 to present 789 results from 76 wells; no screening data available; no data in IRIS		x	x	
Silicon trioxide	x				N	See silicon				
Silver	x				N	Last analyzed for in 2006; from 1988 to present 4277 results from 164 wells: one detect and zero non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Silver nitrate	x				N	See silver and nitrate				
Sodium	x	x			N	Last analyzed for in 2006; from 1988 to present 4359 results from 169 wells; No health risk, radioactive component covered under radioactive constituents		x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Strontium	x				N	Last analyzed for in 2006; from 1988 to present 2589 results from 155 wells: zero detects and zero non-detects exceed PRGs; Non-radiological component; radioactive component under radioactive constituents; no health risk;		x	x	
Thallium					Y	Last analyzed for in 2006; from 1988 to present 542 results from 76 wells: 19 detects and 494 non-detects exceed PRGs; within the last 10 years 5 wells had more than one exceedance		x	x	
Tin	x				N	Last analyzed for in 2000; from 1988 to 2000, 1970 results from 97 wells: zero detects and zero non-detects exceed PRGs			x	
Titanium					N	Last analyzed for in 2006; from 1988 to present 740 results from 64 wells: no PRGs available; no data in IRIS		x	x	
Tungsten	x				N	Not analyzed for in PO-1 groundwater; No PRGs available; no data in IRIS;			x	
Tungsten tetroxide	x				N	See tungsten				
Uranium	x			x	Y	Last analyzed for in 2006; from 1988 to present 982 results from 122 wells: 29 detects and zero non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance; Also covered under radioactive constituents	x	x	x	A-AX Tank Farm 216-A-10 2101-M Pond
Vanadium	x		x	x	Y	Last analyzed for in 2006; from 1988 to present 4285 results from 163 wells: 10 detects and zero non-detects exceed PRGs	x	x	x	
Zinc	x				Y	Last analyzed for in 2006; from 1988 to present 4295 results from 167 wells: 2 detects and zero non-detects exceed PRGs	x	x	x	216-A-36B
Zirconium	x				N	Last analyzed for in 1996; from 1988 to 1996 525 results from 70 wells; no PRGs available; No known carcinogenic or toxic properties;				
Zirconium oxide	x				N	See zirconium				
Zirconyl phosphate	x				N	See zirconium and phosphate				
Nonmetal Contaminants of Potential Concerns										
Ammonia					N	Last analyzed for in 2006: from 1988 to present 693 results from 33 wells; no PRGs available; EPA has not evaluated evidence for carcinogenicity (IRIS)	x	x	x	
Ammonium carbonate	x	x			N	Quantities listed : 400,000 kg in 216-A-21 Crib; considered as ammonium and carbonate		x		
Ammonium fluoride	x				N	See ammonia and fluoride	x			

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Ammonium ion					N	Last analyzed for in 1999; from 1988 to 1999 803 results from 85 wells; no PRGs available; no data in IRIS		x	x	A-AX Tank Farm 216-A-36B 216-A-29 Ditch 216-B-3
Ammonium nitrate	x	x			N	Quantities listed : 320,000 kg in 216-A-8 crib; see ammonium and nitrate	x	x		
Hydrazine	x				N	Last analyzed for in 2001; from 1988 to 2001 421 results from 67 wells: 24 detects and 397 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but that exceedance was a non-detect	x	x	x	216-A-29 Ditch
Hydrobromic acid	x				N	See bromide;				
Hydrochloric acid	x				N	See chloride				
Hydrofluoric acid					N	See fluoride		x		
Hydrogen peroxide	x				N	Not analyzed for in PO-1 groundwater; no screening data available; no data in IRIS				
Hydroxylamine hydrochloride	x				N	Not analyzed for in PO-1 groundwater; no screening data available; no data in IRIS				
Hydroxylamine nitrate	x				N	Not analyzed for in PO-1 groundwater; no screening data available; no data in IRIS	x			
Nitric acid	x	x			N	Not analyzed for in PO-1 groundwater; see nitrate	x	x		
Periodic acid	x				N	Not analyzed for in PO-1 groundwater; no screening data available; no data in IRIS				
Phosphoric acid	x				N	See phosphorus and phosphate				
Phosphorus					N	Last analyzed for in 1996; from 1988 to present one result from one well: one detect and zero non-detects exceeded PRGs;		x		
Phosphorus pentoxide	x				N	See phosphorus and phosphate				
Sodium bisulfate	x				N	See sodium and sulfate				
Sodium bromate	x				N	See sodium and bromide				
Sodium carbonate	x				N	See sodium and carbonate	x			
Sodium dichromate	x	x			N	See sodium and chromium		x		
Sodium ferrocyanide	x				N	See sodium, iron , and cyanide				
Sodium fluoride	x				N	See sodium and fluoride				
Sodium hydroxide	x				N	See sodium and hydroxide	x			
Sodium nitrate	x				N	See sodium and nitrate				
Sodium nitrite	x				N	See sodium and nitrite				
Sodium sulfate	x				N	See sodium and sulfate				
Sodium thiosulfate	x				N	See sodium, sulfate, and sulfur				
Sulfamic acid	x				N	See sodium, sulfate, and sulfur				
Sulfuric acid	x	x			N	See sulfur and sulfate; Quantities listed: 10,000 kg in 216-B-6 reverse well	x			
Sulfur	x				N	Not analyzed for in PO-1 groundwater; no screening data available; no data in IRIS				
Thiocyanate					N	See sulfur and cyanide;	x			
Volatile Organic Contaminants of Potential Concern										
1,1,1-Trichloroethane					N	Last analyzed for in 2006; from 1988 to present 1502 results from 129 wells: zero detect and zero non-detects exceed PRGs;	x	x		
1,1,2,2-Tetrachloroethane					Y	Last analyzed for 2006; from 1988 to present 240 results from 87 wells: One detect and 237 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance,	x		x	
1,1,2-Trichloroethane					N	Last analyzed for in 2006; from 1988 to present 1381 results from 120 wells: zero detects and 373 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance, but exceedances were non-detects	x	x		
1,1-Dichloroethane					N	Last analyzed for in 2006; from 1988 to present 1430 results from 129 wells: zero detects and zero non-detects exceed PRGs		x	x	
1,2-Dichlorobenzene					N	Last analyzed or in 2006; from 1988 to present 232 results from 88 wells: zero detects and zero non-detects exceed PRGs	x			
1,2-Dichloroethane					Y	Last analyzed for in 2006; from 1988 to present 1410 results from 128 wells: 7 detects and 499 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance	x	x	x	

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
1,3-Dichlorobenzene					N	Last analyzed for in 2006; from 1988 to present 232 results from 88 wells; no PRGs available; not a known carcinogen (IRIS)	x			
1,4-Dichlorobenzene					N	Last analyzed for in 2006; from 1988 to present 1633 results from 124 wells: zero detects and 584 non-detects exceed PRGs; within the last 10 years 6 wells had more than one exceedance, but exceedances were non-detects			x	
1-Butanol, butyl alcohol					N	Last analyzed for n 2006; from 1988 to present 531 results from 89 wells: zero detects and 92 non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance	x	x		
1-Butynol					N	Last analyzed for in 1990; from 1988 to 1990 63 results from 41 wells; no PRGs available; no data in IRIS			x	216-A-10
2-Butanone (Methyl ethyl ketone)					N	Last analyzed for in 2006; from 1988 to present 847 results from 118 wells: zero detects and zero non-detects exceed PRGs	x	x	x	
2-Chlorophenol					N	Last analyzed for in 2006; from 1988 to present 1207 results from 92 wells: zero detects and one non-detect exceed PRGs		x		
2-Hexanone					N	Last analyzed for in 2006; from 1988 to present 127 results from 54 wells; no PRGs available; no data in IRIS	x			
2-Propanol (Isopropyl alcohol)	x				N	Last analyzed for in 1995; from 1988 to present 21 results from 20 wells; no PRGs available; no data found in IRIS	x		x	
4-Methyl-2-Pentanone (hexone)					N	Last analyzed for in 2006; from 1988 to present 848 results from 118 wells; no PRGs available; health hazard being reviewed by EPA	x	x	x	
4-chloro 3-methylphenol					N	Last analyzed for in 2006; from 1988 to present 1205 results from 92 wells; no PRGs available; no data in IRIS		x		
Acetone	x				N	Last analyzed for in 2006; from 1988 to present 778 results from 110 wells: zero detects and zero non-detects exceed PRG	x	x	X	
Acetonitrile					N	Last analyzed for in 2006; from 1988 to present 210 results from 75 wells; no PRGs available; not a known human carcinogen (IRIS)	x			
Benzene					Y	Last analyzed for in 2006; from 1988 to present 1442 results from 128 wells: 7 detects and 460 non-detects exceed PRGs; within the last 10 years 6 wells had more than one exceedance	x	x	x	
Bromodichloromethane					Y	Last analyzed for in 2006; from 1988 to present 204 results from 63 wells: one detect and 128 non-detects exceed PRGs			x	
Carbon disulfide					N	Last analyzed for in 2006; from 1988 to present 690 results from 107 wells: zero detects and zero non-detects exceed PRGs			x	
Carbon tetrachloride					Y	Last analyzed for in 2006; from 1988 to present 1496 results from 128 wells: 85 detects and 693 non-detects exceed PRGs; within the last 10 years 23 wells had more than one exceedance	x	x	x	
Chloroform					N	Last analyzed for in 2006; from 1988 to present 1494 results from 129 wells: zero detects and 2 non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance	x	x	x	
cis-1,2-Dichloroethylene					N	Last analyzed for in 2006; from 1988 to present 1012 results from 78 wells: zero detects and zero non-detects exceed PRGs	x	x		
Cyclohexane					N	Not analyzed for in PO-1 groundwater; no screening data available; not a known human carcinogen (IRIS)	x			
Cyclohexanone					N	Not analyzed for in PO-1 groundwater; No data on quantities can be located for this constituent (DOE-RL-2004-39); EPA has not yet evaluated this compound as a human carcinogen (IRIS); No toxicity in data presented; Unplanned releases are generally	x	x		
Dibromochloromethane					Y	Last analyzed for in 2006; from 1988 to present 204 results from 63 wells: one detect and 164 non-detects exceed PRGs			x	
Diethyl ether					N	Last analyzed for in 1996; from 1988 to 1996 20 results from 3 wells: zero detects and 20 non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance		x		
Ethanol					N	Last analyzed for in 1996; from 1988 to 1996 92 results from 44 wells; no PRGs available; no data in IRIS	x	x		

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Ethylbenzene					N	Last analyzed for in 2006; from 1988 to present 934 results from 108 wells: zero detects and zero non-detects exceed PRGs	x	x		
Ethylene glycol					N	Last analyzed in 1996; from 1988 to 1996 92 results from 49 wells: zero detects and zero non-detects exceed PRGs	x	x		
Ethyl cyanide					N	Last analyzed for in 2006; from 1988 to present 636 results from 94 wells; no PRGs available; no data in IRIS		x	x	
Formaldehyde	x				N	Last analyzed for in 1990; from 1988 to 1990 142 results from 62 wells; zero detects and zero non-detects exceed PRGs				
Hexane					Y	Not analyzed for in PO-1 groundwater; EPA lists as a possible human carcinogen; Listed as a 200-UR-1 OU COC from DOE/RL-2004-39 Draft A.	x			
Methyl chloride (Chloromethane)					N	Last analyzed for in 2006; from 1988 to present 239 results from 86 wells: zero detects and 218 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance, but exceedances were non-detects	x			
Methylene chloride					Y	Last analyzed for in 2006; from 1988 to present 1486 results from 129 wells: 22 detects and 113 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance	x	x	x	
Naphthalene					N	Last analyzed for in 2006; from 1988 to present 416 results from 97 wells: zero detects and zero non-detects exceed PRGs	x	x		
Pentachlorophenol					Y	Last analyzed for in 2006; from 1988 to present 1394 results from 94 wells: 6 detects and 1328 non-detects exceed PRGs; within the last 10 years 54 wells had more than one exceedance		x	x	
Phenol					N	Last analyzed in 2006; from 1988 to present 1637 results from 107 wells: zero detects and zero non-detects exceed PRGs	x	x		
Phenols				x	N	Covered by analyzing for separate phenols				A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M-Pond 216-B-3
2,4,5-Trichlorophenol					N	Last analyzed for in 2006, from 1988 to present 704 results from 91 wells: zero detects and zero non-detects exceed PRGs;				
2,4,6-Trichlorophenol					N	Last analyzed for in 2006, from 1988 to present 1149 results from 92 wells: zero detects and 634 non-detects exceed PRGs; within the last 10 years 40 wells had more than one exceedance, but exceedances were non-detects				
2-Cyclohexyl-4,6-dinitrophenol					N	Last analyzed for in 2006; from 1988 to present 57 from 47 wells; No PRGs available; no data in IRIS				
2,6-Dichlorophenol					N	Last analyzed for in 2006; Results from 1143 from 87 wells; No PRGs available; no data in IRIS				
4-Nitrophenol					N	Last analyzed for in 2006; from 1988 to present 1148 results from 92 wells; No PRGs available; no data in IRIS for toxicity				
4,6-Dinitro-2-methylphenol					N	Last analyzed for in 2006; from 1988 to present 1205 results from 92 wells; no PRGs available; no data in IRIS				
Pyrene					N	Last analyzed for in 2006; from 1988 to present 205 results from 62 wells: zero detects and zero-non-detects exceed PRGs		x		
Styrene					N	Last analyzed for in 2006; from 1988 to present 127 results from 54 wells: zero detects and 107 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance, but exceedances were non-detects		x	x	
Tetrachloroethene					Y	Last analyzed for in 2006; from 1988 to present 1442 results from 129 wells: 807 detects and 583 non-detects exceed PRGs; within the last 10 years 30 wells had more than one exceedance	x	x	x	
Tetrahydrofuran					N	Last analyzed for in 2006; from 1988 to present 691 results from 103 wells; no PRGs available; no data in IRIS	x			216-A-10

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Toluene					N	Last analyzed for in 2006; from 1988 to present 1444 results from 129 wells: zero detects and zero non-detects exceed PRGs	x	x		
trans-1,2-Dichloroethylene					N	Last analyzed for in 2006; from 1988 to present 1299 results from 113 wells: zero detects and zero non-detects exceed PRGs	x	x		
Trichloroethane	x				N	Considered as 1,1,1-Trichlorethane and 1,1,2-Trichloroethane				
Trichloroethene					Y	Last analyzed for in 2006; from 1988 to present 1482 results from 129 wells: 746 detects and 659 non-detects exceed PRGs; within the last 10 years 32 wells had more than exceedance	x	x	x	
Trichloromonofluoromethane					N	Last analyzed for in 2006; from 1988 to present 221 results from 79 wells: zero detects and zero non-detects exceed PRGs		x	x	
Vinyl chloride					Y	Last analyzed for in 2006; from 1988 to present 1372 results from 120 wells: 4 detects and 1368 non-detects exceed PRGs; within the last 10 years 30 wells had more than one exceedance	x			
Xylenes (total)					N	Last analyzed for in 2006; from 1988 to present 1252 results from 121 wells: zero detects and zero non-detects exceed PRGs	x	x		
Semivolatile Organics										
2,4-Dichlorophenol					N	Last analyzed for in 2006; from 1988 to present 1296 results from 93 wells: one detect and zero non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance		x		
2,4-Dichlorophenoxyacetic acid; 2,4-D					N	Last analyzed for in 2005; from 1988 to 2005 629 results from 75 wells: zero detects and zero non-detects exceed PRGs			x	
2,4-Dimethylphenol					N	Last analyzed for in 2006; from 1988 to present 1114 results from 88 wells: zero detects and zero non-detect exceed PRGs		x	x	
2,4-Dinitrophenol					Y	Last analyzed for in 2006; from 1988 to present 1148 results from 92 wells: one detect and 292 non-detects exceed PRGs		x	x	
2,4-dinitrotoluene					N	Last analyzed for in 2006; from 1988 to present 225 results from 75 wells: zero detects and zero non-detects exceed PRGs	x	x		
2,3,4,6-tetrachlorophenol					N	Last analyzed for in 2006; from 1988 to present 697 results from 86 wells: zero detects and zero non-detects exceed PRGs		x		
2-methylphenol (o-cresol)					N	Last analyzed for in 2006; from 1988 to present 830 results from 79 wells: zero detects and zero non-detects exceed PRGs	x			
2-Nitrophenol					N	Last analyzed for in 2006; from 1988 to present 1279 results from 86 wells; no PRGs available; no data in IRIS		x	x	
Dinoseb 2-sec Butyl-4,6-dinitrophenol					N	Last analyzed for in 2006; from 1988 to present 1518 results from 88 wells: one detect and 84 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but exceedance was non-detect. The only detect was from 1995.			x	
3-methylphenol					N	Last analyzed for in 2000; from 1988 to 2000 150 results in 39 wells; zero detects and zero non-detects exceed PRGs		x		
4-methylphenol (p-cresol)					N	Last analyzed for in 2006; from 1988 to present 251 results from 56 wells: zero detects and zero non-detects exceed PRGs	x	x		
Benzo [a] anthracene					N	Last analyzed for in 2006; from 1988 to present 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Benzo [a] pyrene					N	Last analyzed for in 2006; from 1988 to present 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Benzo[b] fluoranthene					N	Last analyzed for in 2006; from 1988 to present 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Benzo [k] fluoranthene					N	Last analyzed for in 2006; from 1988 to present 148 results from 62 wells: zero detects and 148 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x			

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Bis (2-ethylhexyl) phthalate					Y	Last analyzed for in 2006; from 1988 to present 384 results from 82 wells: 15 detects and 107 non-detects exceed PRGs		x	x	
Butylated hydroxy toluene					N	Not analyzed for in PO-1 groundwater; no screening data available; no data in IRIS	x	x	x	216-A-36B
Chlorobenzene					N	Last analyzed for in 2006; from 1988 to present 365 results from 90 wells: zero detects and zero non-detects exceed PRGs	x	x		
Chrysene					N	Last analyzed for in 2006; from 1988 to present 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Dibenz [a,h] anthracene					N	Last analyzed for in 2006; from 1988 to present 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Dibutyl butyl phosphonate	x				N	Not analyzed for in PO-1 groundwater; will degrade to phosphate and will be detected as such	x			
Dibutylphosphate					N	Last analyzed for in 1990; from 1988 to 1990 72 results from 41 wells; no PRG available; no known health hazards or toxicity;		x	x	216-A-10
Diethylphthalate					N	Last analyzed for in 2006; from 1988 to present 168 results from 75 wells: zero detects and zero non-detects exceed PRGs	x			
Di-n-Butylphthalate					N	Last analyzed for in 2006; from 1988 to present 169 results from 75 wells: zero detects and zero non-detects exceed PRGs	x			
Hydroxyacetic acid (Glycolate)	x				N	Not analyzed for in Hanford groundwater; No toxicity/carcinogenicity data available in EPA databases. Continued radionuclide measurements in GW will detect any increased mobility of radionuclides.				
Indeno [1,2,3-cd] pyrene					N	Last analyzed for in 2006; from 1988 to present 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Monobutyl phosphate					N	Last analyzed for in 1990; from 1988 to 1990 72 results from 41 wells; no PRG available; no data in IRIS			x	216-A-10
Naphthylamine					N	Analyzed for as 1-Naprthylamine and 2-Naphthylamine; found in groundwater	x			
n-butyl benzene					N	Not analyzed for in PO-1 groundwater; no PRGs; no data in IRIS	x	x		
N-Nitrosodiphenylamine					N	Last analyzed for in 2006; from 1988 to present 148 results from 62 wells: no PRGs available; IRIS lists as a probable human carcinogen			x	
Polychlorinated dibenzo-p-dioxins					N	Last analyzed for in 1993; from 1988 to 1993 44 results in 41 wells; no PRGs available; no data for this in IRIS			x	
Polychlorinated dibenzofurans					N	Last analyzed for in 1993; from 1988 to 1993 44 results in 41 wells; no PRGs available; no data for this in IRIS			x	
Tetrachlorophenol					N	Last analyzed for in 1996; from 1988 to 1996 446 results for 53 wells: zero detects and zero non-detects			x	
Thenoyltrifluoroaceton e	x				N	Not analyzed for in PO-1 groundwater; no PRGs available; no data in IRIS				
Tributyl phosphate	x	x			N	Last analyzed for in 2006; from 1988 to present 402 results from 94 wells; no PRGs available; Quantities listed: 100,000 kg in 216-A-7 crib and other waste disposal sites; A concern with TBP is that it might carry radionuclides with it as it migrates. Because monitoring for radionuclides exists, there is little reason to look for this further. Degradation of this compound would be detected as phosphate.	x	x		216-A-10
Trichlorophenol					N	Last analyzed for in 1996; from 1988 to 1996 446 results from 53 wells: zero detect and zero non-detect exceed PRGs				
Tri-n-dodecylamine	x				N	Not analyzed for in PO-1 groundwater; no PRGs available; no data in IRIS			x	
Tris-2-chloroethyl phosphate					N	Last analyzed for in 2006; from 1988 to present 180 results from 37 wells: No PRGs available; no data in IRIS			x	

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Hydrocarbons										
Decane					N	Last analyzed for in 1996; from 1988 to 1996 151 results from 28 wells: no PRGs available; no data in IRIS	x	x		
Total petroleum hydrocarbons diesel range, (diesel fuel)					N	Last analyzed for in 2005; from 1988 to 2005 41 results from 10 wells: no detects above PRGs	x	x		
Dodecane					N	Last analyzed for in 1996; from 1988 to 1996 151 results from 29 wells: no PRGs available; no data in IRIS	x			
Hydraulic fluids (oil and greases)					N	Last analyzed for in 2005; from 1988 to 2005 109 results from 6 wells; no detects above PRGs	x			
Kerosene (TPH kerosene range)					N	Last analyzed for in 2001; from 1988 to 2001 159 results from 79 wells; no detects above PRGs; no data in IRIS	x	x		
Lard oil					N	No toxicity factors	x			
Paint thinner					N	See other organic volatiles and hydrocarbons; no detects for toluene	x			
Paraffin hydrocarbons NPH	x	x			N	see TPH	x			
Shell E-2342 (naphthalene and paraffin)					N	See naphthalene and paraffin NPH	x			
Soltrol-170 (purified kerosene)					N	See kerosene (TPH kerosene range)	x			
Pesticide Contaminants of Potential Concern										
2,4,5-TP Silvex					N	Last analyzed for in 2005; from 1988 to 2005 629 results from 75 wells: zero detects and zero non-detects exceed PRGs			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3
4,4'-DDD					N	Last analyzed for in 2005; from1988 to 2005 467 results from 77 wells: zero detects and zero non-detects		x	x	
4,4'-DDE					N	Last analyzed for in 2005; from 1998 to 2005 467 results from 77 wells: zero detects and zero non-detects exceed PRGs			x	
4,4'-DDT					N	Last analyzed for in 2005; 467 results from 77 wells: 3 detects and zero non-detects exceed PRGs; within last 10 years zero wells had more than one exceedance		x	x	
Aldrin					N	Last analyzed for in 2005; from 1998 to 2005 467 results form 77 wells: 4 detects and 411 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance, but exceedances are all non-detects. The 4 detects are all prior to 1995.		x	x	
Alpha BHC					N	Last analyzed for in 2005; from 1988 to 2005 624 results from 78 wells: zero detects and 472 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance, but exceedances were non-detects;)			x	
Delta- BHC					N	Last analyzed for in 2005; from 1988 to 2005 624 results from 78 wells: no PRGs available; not a known human carcinogen (IRIS)			x	
Dieldrin					Y	Last analyzed for in 2005; from 1988 to 2005 467 results from 77 wells: 3 detects and 401 non-detects exceed PRGs		x	x	
Dimethoate					Y	Last analyzed for in 2006; from 1988 to present 155 results from 62 wells: 3 detects and 73 non-detects exceed PRGs		x	x	
Endosulfan sulfate					N	Last analyzed for in 2005; from 1988 to 2005 454 results from 72 wells; no PRGs available; no data in IRIS			x	
Endrin					N	last analyzed for in 2005; from 1988 to 2005 624 results from 78 wells: 3 detects and zero non-detects exceed PRGs; within the last 10 years zero wells exceeded		x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Endrin aldehyde					N	Last analyzed for in 2005; from 1988 to 2005 409 results from 57 wells; no PRGs available; no data in IRIS		x	x	
Heptachlor					Y	Last analyzed for in 2005; from 1988 to 2005 467 results from 77 wells: 7 detects and 325 non-detects exceed PRGs		x	x	
Heptachlor epoxide					Y	Last analyzed for in 2005; from 1988 to 2005 467 results from 77 wells: 2 detects and 344 non-detects exceed PRGs			x	
Lindane (Gamma BHC)					N	Last analyzed for in 2005; from 1988 to 2005 624 results from 78 wells: 3 detects and 213 non-detects exceed PRGs; within the last 10 years zero wells had exceedances		x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3
Methoxychlor					N	Last analyzed for in 2005; from 1988 to 2005 624 results from 78 wells: zero detects and zero non-detects exceed PRGs			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3
Phorate					N	Last analyzed for in 2006; from 1988 to present 108 results from 47 wells: zero detects and 26 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but exceedance was non-detect		x	x	
Toxaphene					N	Last analyzed for in 2005; from 1988 to 2005 624 results from 78 wells: zero detects and 624 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3
Complexants										
Citrate	x				N	Not analyzed for in PO-1 groundwater; May increase the mobility of metals and radionuclides. Continued radionuclide measurements in GW will detect any increased mobility.				
EDTA	x				N	Chelator, no toxicity data available. May increase mobility of metals and radionuclides. Continued radionuclide measurements in the GW will detect any increased mobility of radionuclides. Not analyzed for in Hanford groundwater.				
Glycolate (Hydroxyacetic acid)	x				N	No toxicity/carcinogenicity data available in EPA databases. Continued radionuclide measurements in GW will detect any increased mobility of radionuclides. Not analyzed for in Hanford groundwater				
HEDTA	x				N	Chelator, no toxicity data available. May increase mobility of metals and radionuclides. Continued radionuclide measurements in the GW will detect any increased mobility of radionuclides. Not analyzed for in Hanford groundwater.				
Oxalic acid	x				N	Not analyzed for in PO-1 groundwater; no data in IRIS				
Tartaric acid	x				N	Not analyzed for in PO-1 groundwater; no data in IRIS				
Miscellaneous										
Aroclor-1254					N	Last analyzed for in 2005; from 1988 to 2005 146 results from 69 wells: zero detects and 115 non-detects exceed PRGs; within the last 10 years zero wells had exceedances	x			
Aroclor-1260					N	Last analyzed for in 2005; from 1988 to 2005 146 results from 69 wells; no PRGs available; no data in IRIS		x		
Polychlorinated biphenyls (total)					N	Will be considered as separate Aroclors.	x			
Sugar	x				N	Not analyzed for in PO-1 groundwater; not a toxin or known carcinogen				
Water Quality Measurements										
Alkalinity				x	N	General water quality evaluation parameter; pH will cover general water quality			x	

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Coliform bacteria					N	Water Quality parameter			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
pH				x	N	General water quality evaluation parameter that affects transport in CERCLA risk evaluation. GW not expected to have significantly acidic or alkaline pH.	x		x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Specific conductance				x	N	Provides no definitive information for risk assessment			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Temperature					N				x	
Total organic carbon				x	N	General water quality evaluation parameter that affects transport in CERCLA risk evaluation,			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Turbidity				x	N	General water quality and assesses whether filtration is successful. Provides no definitive information for risk assessment.			x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Anions										
Bromide					N	Last analyzed for in 2006; from 1988 to present 1728 results from 132 wells; no PRGs available; no data in IRIS	x	x		
Carbonate	x				N	Not analyzed for in PO-1 groundwater; no PRGs available; no data in IRIS				
Chloride	x				N	Last analyzed for in 2006; from 1988 to present 3993 results from 183 wells; no screening data available, no data in IRIS	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Cyanide	x		x	x	N	Last analyzed for in 2006; from 1988 to present 314 results from 111 wells: zero detects and zero non-detects exceed PRGs. Retained in DQO for PO-1 and BP-5	x	x	x	
Fluoride	x	x			Y	Last analyzed for in 2006; from 1988 to present 4119 results from 183 wells: 163 detects and 10 non-detects exceed PRGs; within the last 10 years 7 wells had more than one exceedance	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Hydroxide	x				N	See alkalinity and pH				

Table E1-3. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (12 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU source COPC[k]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Unit Where Monitoring is Required[i]
Nitrate		x	x	x	Y	Last analyzed for in 2006; from 1988 to present 4400 results from 189 wells: 481 detects and zero non-detects exceed PRGs. Within the last 10 years 19 wells had more than one exceedance; part of a regional plume	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Nitrite		x			Y	Last analyzed for in 2006; from 1988 to present 3410 results from 182 wells: one detects and zero non-detects exceed PRGs; within the last 10 years one well had more than one exceedance	x	x	x	
Oxalate		x			N	Not analyzed for in PO-1 groundwater; no screening data available, no data in IRIS				
Perchlorate ion					N	Last analyzed for in 1995; from 1988 to 1995 70 results from 41 wells; zero detects and 70 non-detects exceed PRGs; within the last 10 years zero wells had exceedances			x	
Phosphate		x			N	Last analyzed for in 2006; from 1988 to present 1832 results from 139 wells; no PRGs available; Quantities listed : 100,000 kg in 216-B-19 crib and B-33 trench; degradation product from TBP, DBP, and DDBP.	x	x	x	
Sulfate		x			N	Last analyzed for in 2006; from 1988 to present 4059 results from 183 wells; no PRGs available; no data in IRIS	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Sulfide					N	Last analyzed for in 2006; from 1988 to present 119 results from 66 wells; no PRGs available; no data in IRIS	x	x		

[a] DOE/RL-92-04, *PUREX Source Aggregate Area Management Study Report.*
[b] DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
[c] PNNL-14049, *Data Quality Objectives Summary Report - Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units.*
[d] CP-15329, *Data Quality Objectives Summary Report for Establishing RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network.*
[e] COPCs are noted as "Y" or "N". "Y" represents constituents included as COPCs, and "N" represents a constituent that has been removed from the final list of COPCs
[f] Logic for COPC inclusion or exclusion from final list of COPCs
[g] Other sources refers to ancillary documents that provided duplicative COPCs; see below:
D&D-28283, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit.*
DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan.*
DOE/RL-2000-60, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units.*
DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*
DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan, : 200-LW-1 and 200-LW-2 Operable Units.*
DOE/RL-2002-11, *300-FF-5 Operable Unit Sampling and Analysis Plan.*
DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*
DOE/RL-2004-17, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit.*
DOE/RL-2004-24, *Feasibility Study for the 200-CW-5 (U Pond/Z Ditches Cooling Water Waste Group), 200-CW-2 (S Pond and Ditches Cooling Water Waste Group), 200-CW-4 (T Pond and Ditches Cooling Water Waste Group), and 200-SC-1 (Steam Condensate Waste Group) Operable Units.*
DOE/RL-2004-39, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis.*
DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*
[h] DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit.*
[i] RCRA treatment, storage, and disposal sites for the 200-PO-1 Groundwater Operable Unit per analyte as presented in DOE/RL-95-100.
[j] Quantities listed in DOE/RL-92-19.
[k] Half lives from EPA, 2001, *Health Effects Assessment Summary Tables* database, "Update of Radionuclide Carcinogenicity Slope Factors," "April 16, 2001 Update: Radionuclide Toxicity," available on the Internet at . http://www.epa.gov/radiation/heast/.
[l] DOE/RL-2006-55, *Sampling and analysis Plan for FY 2006 200-BP-5 groundwater Operable Unit Remedial Investigation/Feasibility Study.* COPCs noted here are from the 200-BP-5 OU and WMP-28945, *Data Quality Objective Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/ Feasibility Study Process.*
[m] K_d values from PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*

Table E1-4. Radiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (4 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[i]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Units Where Monitoring is Required[i]
Actinium-225	x				N	Short half life (10 days);		x		
Actinium-227	x				N	Tightly bound to soil; will decay before reaching groundwater		x		
Americium-241	x	x			N	Last analyzed for in 2000; from 1988 to 2000 19 results from 18 wells: zero detects and 3 non-detects exceed regulatory limits; Tightly bound to soil; highest concentrations released to B pond at 3.96 Ci[j]; will decay before reaching groundwater	x	x		
Americium-242	x				N	Short half life (16 hours)[k]		x		
Americium-242m	x				N	Not analyzed for in PO-1 groundwater; tightly bound to soil, Half life (152 years)[k]		x		
Americium-243					N	Not analyzed for in PO-1 groundwater; tightly bound to soil; Half life (7,380 years)[k]		x		
Antimony-125					N	Last analyzed in 2006; from 1988 to present 675 results from 113 wells; no regulatory limits available; Short half life (2.77 years)[k]; will not contribute to dose if reached groundwater in 100 to 200 years	x	x		
Antimony-126	x				N	Short half life (12.4 days)[k]; will not contribute to dose if reached groundwater in 100 to 200 years		x		
Antimony-126m					N	Short half life (19.0 minutes)[k;]		x		
Astatine-217	x				N	Short half life (0.0323 seconds)[k]				
Barium-137m					N	Short half life (38.9 hours)[k]		x		
Beryllium-7	x				N	Short half life (53.44 days)[k]		x		
Bismuth-210	x				N	Short half life (5.012 days)[k]		x		
Bismuth-211	x				N	Short half life (2.14 minutes)[k]		x		
Bismuth-212					N	Short half life (60.6 minutes)		x		
Bismuth-213	x				N	Short half life (45.65 minutes)[k]		x		
Bismuth-214	x				N	Short half life (19.9 minutes)[k]		x		
Carbon-14	x				N	Last analyzed for in 2000; from 1988 to 2000, 20 results from 7 wells: zero detects and zero non-detects exceed regulatory limits; Present in process waste; high mobility; half life (5,730 years)[k]	x	x		
Cerium/ Praseodymium-144	x				N	Short half life (284.3 days)[k]; tightly bound to soil; eliminated in FIR as COPC		x	x	
Cesium-134	x				N	Last analyzed for in 2006; from 1988 to present 476 results from 89 wells; no regulatory limits available; Short half life (2.062 years)[k]	x	x		
Cesium-135					N	Not analyzed for in PO-1 groundwater; bound tightly to soil; Half life (2,300,000 years)[k;]		x		
Cesium-137	x	x			N	Last analyzed for in 2006; from 1988 to present 1078 results from 138 wells: zero detect and one non-detect exceed regulatory limits; Values highest were in 216-A-36A crib at 847.0 Ci[j;] Half life (30 years)[k]	x	x	x	A-AX Tank Farm
Chlorine-36					N	Not analyzed for in PO-1 groundwater; As discussed in Kincaid et al (1998) based on ORIGEN runs the Cl activity would be about 0.025% of Tc-99 activity. The dose response factor (mrem/yr per pCi/L) would be about 10 times more than Tc-99. Thus any dose would be less than 1% of the Tc-99 dose K_d value of 0 in groundwater [m;] Half life (301,000 years)[k]		x		
Cobalt-58	x				N	Short half life (70.8 days)[k]				
Cobalt-60	x	x	x	x	N	Last analyzed for in 2006; from 1988 to present 1078 results from 138 wells: zero detects and zero non-detects exceed regulatory limits; high k_d 1200 mL/g; largest quantities were released in 216-A-5 crib at 3.32 Ci[j;] Half life (5.27 years)[k]	x	x	x	A-AX Tank Farm
Curium-242	x				N	Short half life (162.8 days)[k]; Strongly bound to soil				
Curium-244	x				N	Not analyzed for in PO-1 groundwater; Strongly bound to soil, will not reach groundwater; half life (18.1 years)[k]		x		

Table E1-4. Radiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (4 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[i]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Units Where Monitoring is Required[i]
Curium-245	x				N	Not analyzed for in PO-1 groundwater; Strongly bound to soil, will not reach groundwater; half life (8,500 years)[k]		x		
Europium-152	x				N	Last analyzed for in 2006; from 1988 to present 287 results from 68 wells: zero detects and zero non-detects exceed regulatory limits; Half life (13 years)[k]; strongly bound to soil; will decay before reaching groundwater	x	x		
Europium-154	x				N	Last analyzed for in 2006; from 1988 to present 509 results from 94 wells: zero detects and zero non-detects; Half life (8.8 years)[k]; strongly bound to soil; will decay before reaching groundwater	x	x		
Europium-155	x				N	Last analyzed for in 2006; from 1988 to present 508 results from 93 wells: zero detects and zero non-detects exceed regulatory limits; Half life (4.96 years)[k]; strongly bound to soil; will decay before reaching groundwater	x	x		
Francium-221	x				N	Short half life (4.8 minutes)[k]		x		
Francium-223	x				N	Short half life (21.8 minutes)[k]		x		
Gamma scan				x		See individual isotopes			x	A-AX Tank Farm 216-A-10
Gross alpha		x		x	Y	Last analyzed for in 2006; from 1988 to present 2919 results from 170 wells: 34 detects and zero non-detects exceed background; within the last 10 years 3 wells had more than one exceedance; Not useful for risk assessment; eliminated in FIR as COPC	x		x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Gross beta		x		x	N	Last analyzed for in 2006; 3368 results from 178 wells; Not useful for risk assessment;	x		x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 2101-M Pond 216-B-3
Iodine-129	x	x	x	x	Y	Last analyzed for in 2006; from 1988 to present 1364 results from 166 wells: 629 detects and 56 non-detects exceed regulatory limits; within the last 10 years 47 wells had more than one exceedance; part of a regional plume; potential dose contributor; values 0.107 found in 216-A-10 crib[j]; FIR retained for analysis in monitoring wells; half life (15,700,000 years)[k]	x	x	x	A-AX Tank Farm
Iodine-131					N	Short half life (8 days)[k]			x	
Lead-209	x				N	Naturally occurring; short half life (3.253 hours)[k]		x		
Lead-210	x				N	Not analyzed for in PO-1 groundwater; Naturally occurring, decay product; Half life (22.3 years)[k]		x		
Lead-211	x				N	Short half life (36.1 minutes)[k]		x		
Lead-212	x				N	Short half life (10.64 hours)[k]		x	x	
Lead-214	x				N	Short half life (26.8 minutes)[k]		x		
Manganese-54	x				N	Short half life (312.5 days)[k]				
Neptunium-237	x				Y	Not analyzed for in PO-1 groundwater; Potential high mobility; long-lived alpha emitter; potential dose contributor; Half life (2,140,000 years)[k]	x	x		
Neptunium-239	x				N	Not analyzed for in PO-1 groundwater; short half life (2.355 days)[k]		x		
Nickel-63	x				N	Last analyzed for in 2004; from 1988 to 2004 13 results from one well; no regulatory limits available; Tightly bound to soil, will not contribute to significant dose in 1,000 yr. period; Half life (96 years)[k]	x	x		
Nickel-64	x				N	Short half life (2.5 hours)[k]				
Palladium-107	x				N	Not analyzed for in PO-1 groundwater; no analytical method for determination; Half life (6,500,000 years)[k]				

Table E1-4. Radiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (4 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[i]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Units Where Monitoring is Required[i]
Plutonium-238	x	x			N	Last analyzed for in 2003; from1988 to 2003 167 results from 58 wells: zero detects and zero non-detects exceed regulatory limits; Tightly bound to soil;	x	x	x	A-AX Tank Farm
Plutonium-239/240	x	x			N	Last analyzed for in 2003; 166 results from 57 wells: zero detects and zero non-detects exceed regulatory limits; Tightly bound to soil;	x	x	x	A-AX Tank Farm
Plutonium-241	x	x			N	Short half life (14.4 years)[k];		x	x	A-AX Tank Farm
Polonium-210	x				N	Short half life (138.38 days)[k]		x		
Polonium-213	x				N	Short half life (4.2 microseconds)[k]				
Polonium-214	x				N	Short half life (164.3 microseconds)[k]		x		
Polonium-215	x				N	Short half life (0.00178 seconds)[k]		x		
Polonium-218	x				N	Short half life (3.05 minutes)[k]		x		
Potassium-40	x				N	Last analyzed for in 2006; from 1988 to present 464 results from 77 wells; No regulatory limits; half life (1,280,000,000 years)[k]		x		
Promethium-147	x	x			N	Not analyzed for in PO-1 groundwater; Short half life (2.62 years)[k]; values found at 1.99 Ci in 216-A-36B crib; quantities disposed of numerous cribs		x		
Protactinium-231	x				Y	Not analyzed for in PO-1 groundwater; Potentially mobile radionuclide; Half life (32,800 years)		x		
Protactinium-233	x				N	Short half life (27 days)[k]				
Protactinium-234					N	Short half life (6.7 hours)[k]		x		
Protactinium-234m	x				N	Short half life (1.17 minutes)[k]		x		
Radium-223	x				N	Short half life (11.4 days)[k]		x		
Radium-224					N	Short half life (3.66 days)[k]		x		
Radium-225	x				N	Short half life (14.8 days)[k]		x		
Radium-226	x				N	Last analyzed for in 2000; from 1988 to 2000 75 results from 7 wells; Naturally occurring; tightly bound to soil,	x	x	x	
Radium-228					N	Last analyzed for in 2000; from 1988 to 2000 59 results from 5 wells; no regulatory limits available; Toxicity data (IRIS) under review with EPA; Half life (5.75 years)[k]	x	x		
Radon-220					N	Short half life (55 seconds)[k]		x		
Radon-222					N	Short half life (3.8 days)[k]		x		
Rhodium-106					N	Short half life (30 seconds)[k]		x		
Ruthenium-101					N	Not analyzed for in PO-1 groundwater; Stable isotope, not radioactive				
Ruthenium-103	x				N	Short half life (39.2 days)[k]			x	
Ruthenium-106	x	x			N	Short half life (368 days)[k]; tightly bound to soil; values found at 3.17 Ci in 216-A-36B crib[j]; eliminated in FIR		x	x	
Samarium-151	x				N	Not analyzed for in Hanford groundwater; Tightly bound to soil; will not reach groundwater in 1,000 years		x		
Selenium-79	x				Y	Not analyzed for in PO-1 groundwater; long half life (65,000 years); potential dose contributor;		x		
Strontium-90	x	x	x	x	Y	Last analyzed for in 2006; from 1988 to present 832 results from 102 wells: 52 detects and 3 non-detects exceed regulatory limits; within the last 10 years 2 wells had more than one exceedance; Part of process history; long half life (29 years)[k]; values found at 978.0 in 216-A-36A crib[j]; FIR retained for analysis in monitoring wells	x	x	x	A-AX Tank Farm
Technetium-99	x		x	x	Y	Last analyzed for in 2006; from 1988 to present 735 results from 146 wells: 13 detects and zero non-detects exceed regulatory limits; within the last 10 years 2 wells had more than one exceedance; Part of process history; long half life (214,000 years)[k]; very mobile;	x	x	x	
Thallium-207	x				N	Short half life (4.77 minutes)[k]		x		
Thallium-208	x				N	Short half life (3.07 minutes)[k]				
Thorium-227	x				N	Short half life (18.7 days)[k]		x		
Thorium-229	x				N	Not analyzed for in PO-1 groundwater; Tightly bound to soil; will not reach groundwater in 1,000 years; Half life (1.91 years)[k]		x		

Table E1-4. Radiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (4 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[l]	RCRA FIR for 200-PO-1 COPCs[h]	RCRA TSD Units Where Monitoring is Required[i]
Thorium-230	x				N	Not analyzed for in PO-1 groundwater; Tightly bound to soil; will not reach groundwater in 1,000 years; Half life (77,000 years)[k]		x		
Thorium-231	x				N	Short half life (25.5 hours)[k]		x		
Thorium-232					N	Last analyzed for in 1992; from 1988 to 1992 6 results from 3 wells; no regulatory limits available; No data in IRIS; Generally tightly bound to soil; Half life (14,100,000,000 years)[k]	x	x		
Thorium-233	x				N	Not analyzed for in Hanford groundwater; cannot locate a half life				
Thorium-234	x				N	Short half life (24.1 days)[k]		x		
Tin-113	x	x			N	Not analyzed for in PO-1 groundwater; High k_d >50[m]; Half life (115 years)[k]				
Tin-126	x				N	Not analyzed for in PO-1 groundwater; Generally tightly bound to soil; Half life (100,000 years)[k]				
Tritium	x	x	x	x	Y	Last analyzed for in 2006; fro 1988 to present 4020 results from 183 wells: 2085 detects and zero non-detects exceed regulatory limits; within the last 10 years 73 wells had more than one exceedance; part of a regional plume; potential dose contributor; values in 18,500 Ci in 216-A-10 crib[j]; FIR retained for analysis in monitoring wells	x	x	x	A-AX Tank Farm 216-A-10 216-A-36B 216-A-29 Ditch 216-B-3
Uranium-233/234	x				N	Last analyzed for in 1992; one result from one well: zero detect and zero non-detect exceed regulatory limits;	x	x	x	A-AX Tank Farm 216-A-10 2101-M Pond
Uranium-234	x				Y	Last analyzed for in 2006; from 1988 to present 111 results from 29 wells: 4 detects and zero non-detects exceed regulatory limits; potential dose contributor	x	x	x	A-AX Tank Farm 216-A-10 2101-M Pond
Uranium-235	x				N	Last analyzed for in 2006; from 1988 to present 116 results from 29 wells: zero detects and 3 non-detects exceed regulatory limits; within the last 10 years one well had more than one exceedance; potential dose contributor	x	x	x	A-AX Tank Farm 216-A-10 2101-M Pond
Uranium-238	x	x			Y	Last analyzed for in 2006; from 1988 to present 116 results from 29 wells: 5 detects and 3 non-detects exceed regulatory limits; within the last 10 years 2 wells had more than one exceedance; potential dose contributor; values found at 13.1 Ci in 216-A-19 trench[j]	x	x	x	A-AX Tank Farm 216-A-10 2101-M Pond
Yttrium-90	x				N	Short half life (64.0 hours)[k]		x		
Zinc-65	x				N	Short half life (243.9 days)[k]		x	x	
Zirconium-93	x				N	Not analyzed for in PO-1 groundwater; generally bound tightly to soil; Long lived radionuclide (1,530,000 years)[k]		x		
Zirconium/Niobium-95					N	Short half life (63.9 days)[k]; eliminated in FIR as COPC		x	x	

[a] DOE/RL-92-04, *PUREX Source Aggregate Area Management Study Report.*
[b] DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
[c] PNNL-14049, *Data Quality Objectives Summary Report - Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units.*
[d] CP-15329, *Data Quality Objectives Summary Report for Establishing RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network.*
[e] COPCs are noted as "Y" or "N". "Y" represents constituents included as COPCs, and "N" represents a constituent that has been removed from the final list of COPCs
[f] Logic for COPC inclusion or exclusion from final list of COPCs
[g] Other sources refers to ancillary documents that provided duplicative COPCs; see below:
D&D-28283, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit.*
DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan.*
DOE/RL-2000-60, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units.*
DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*
DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan, : 200-LW-1 and 200-LW-2 Operable Units.*
DOE/RL-2002-11, *300-FF-5 Operable Unit Sampling and Analysis Plan.*
DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*
DOE/RL-2004-17, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit.*
DOE/RL-2004-24, *Feasibility Study for the 200-CW-5 (U Pond/Z Ditches Cooling Water Waste Group), 200-CW-2 (S Pond and Ditches Cooling Water Waste Group), 200-CW-4 (T Pond and Ditches Cooling Water Waste Group), and 200-SC-1 (Steam Condensate Waste Group) Operable Units.*
DOE/RL-2004-39, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis.*
DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*
[h] DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit.*
[i] RCRA treatment, storage, and disposal sites for the 200-PO-1 Groundwater Operable Unit per analyte as presented in DOE/RL-95-100.
[j] Quantities listed in DOE/RL-92-19.
[k] Half lives from EPA, 2001, *Health Effects Assessment Summary Tables* database, "Update of Radionuclide Carcinogenicity Slope Factors," "April 16, 2001 Update: Radionuclide Toxicity," available on the Internet at . http://www.epa.gov/radiation/heast/.
[l] DOE/RL-2006-55, *Sampling and analysis Plan for FY 2006 200-BP-5 groundwater Operable Unit Remedial Investigation/Feasibility Study.* COPCs noted here are from the 200-BP-5 OU and WMP-28945, *Data Quality Objective Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/ Feasibility Study Process.*
[m] K_d values from PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*

E1.3 EVALUATION OF ANALYTICAL RESULTS FOR THE 200-PO-1 GROUNDWATER OPERABLE UNIT MONITORING WELL NETWORK

The analytes listed below provide a summary of the formal evaluation process and are shown in the data tables presented in Section E1.1.

- **1,1,2,2-Tetrachloroethane:** One well had exceedances in the last 18 years. 240 analyses from 87 wells resulted in one detect and 237 nondetects that exceed PRGs.
- **1,2-Dichloroethane:** 7 wells had exceedances in the last 18 years. 1,410 analyses from 128 wells resulted in 7 detects and 499 nondetects that exceed PRGs.
- **1,4-Dioxane:** One well had exceedances in the last 18 years. 526 analyses from 100 wells resulted in one detect and 441 nondetects that exceed PRGs.
- **2,4-Dinitrophenol:** One well had exceedances in the last 18 years. 1148 analyses from 92 wells resulted in one detect and 292 nondetects that exceed PRGs.
- **Antimony:** 33 wells had exceedances in the last 18 years. 4,255 analyses from 162 wells resulted in 42 detects and 3,912 nondetects that exceed PRGs.
- **Arsenic:** 35 wells had exceedances in the last 18 years. 2,147 analyses from 101 wells resulted in 236 detects and 11 nondetects that exceed PRGs.
- **Benzene:** 6 wells had exceedances in the last 18 years. 1,442 analyses from 128 wells resulted in 7 detects and 460 nondetects that exceed PRGs.
- **Bis (2-ethylhexyl) phthalate:** 13 wells had exceedances in the last 18 years. 384 analyses from 82 wells resulted in 15 detects and 107 nondetects that exceed PRGs.
- **Bromodichloromethane:** One well had exceedances in the last 18 years. 204 analyses from 63 wells resulted in one detect and 128 nondetects that exceed PRGs.
- **Cadmium:** 5 wells had exceedances in the last 18 years. 4,415 analyses from 162 wells resulted in 6 detects and zero nondetects that exceed PRGs.
- **Carbon tetrachloride:** 18 wells had exceedances in the last 18 years. 1,496 analyses from 128 wells resulted in 85 detects and 693 nondetects that exceed PRGs.
- **Chromium:** 38 wells had exceedances in the last 18 years. 4,424 analyses from 162 wells resulted in 173 detects and zero nondetects that exceed PRGs.
- **Dibromochloromethane:** One well had exceedances in the last 18 years. 204 analyses from 63 wells resulted in one detect and 164 nondetects that exceed PRGs.

- **Dieldrin:** 3 wells had exceedances in the last 18 years. 467 analyses from 77 wells resulted in 3 detects and 401 nondetects that exceed PRGs.
- **Dimethoate:** 2 wells had exceedances in the last 18 years. 155 analyses from 62 wells resulted in 3 detects and 73 nondetects that exceed PRGs.
- **Fluoride:** 40 wells had exceedances in the last 18 years. 4119 analyses from 183 wells resulted in 163 detects and 10 nondetects that exceed PRGs.
- **Gross alpha:** 11 wells had exceedances in the last 18 years. 2,919 analyses from 170 wells resulted in 34 detects and zero nondetects that exceed PRGs.
- **Heptachlor:** 6 wells had exceedances in the last 18 years. 467 analyses from 77 wells resulted in 7 detects and 325 nondetects that exceed PRGs.
- **Heptachlor epoxide:** 2 wells had exceedances in the last 18 years. 467 analyses from 77 wells resulted in 2 detects and 344 nondetects that exceed PRGs.
- **Hexane:** No analyses have been performed in the 200-PO-1 Groundwater OU. This analyte has a PRG of 480 µg/L.
- **Iodine-129:** 78 wells had exceedances in the last 18 years. 1,364 analyses from 166 wells resulted in 629 detects and 56 nondetects that exceed PRGs.
- **Lead:** 10 wells had exceedances in the last 18 years. 1,968 analyses from 109 wells resulted in 13 detects and 17 nondetects that exceed PRGs.
- **Manganese:** 4 wells had exceedances in the last 18 years. 4,298 analyses from 164 wells resulted in 5 detects and zero nondetects that exceed PRGs.
- **Methylene chloride:** 19 wells had exceedances in the last 18 years. 1,486 analyses from 129 wells resulted in 22 detects and 113 nondetects that exceed PRGs.
- **Neptunium-237:** No analyses have been performed in the 200-PO-1 Groundwater OU. This analyte has a PRG of 15 pCi/L.
- **Nickel:** 3 wells had exceedances in the last 18 years. 4,267 analyses from 162 wells resulted in 4 detects and zero nondetects that exceed PRGs.
- **Nitrate:** 35 wells had exceedances in the last 18 years. 4,400 analyses from 189 wells resulted in 481 detects and zero nondetects that exceed PRGs.
- **Nitrite:** One well had exceedances in the last 18 years. 3,410 analyses from 182 wells resulted in one detect and zero nondetects that exceed PRGs.
- **Nitrobenzene:** One well had exceedances in the last 18 years. 168 analyses from 75 wells resulted in one detect and 119 nondetects that exceed PRGs.

- **Pentachlorophenol:** 4 wells had exceedances in the last 18 years. 1,394 analyses from 94 wells resulted in 6 detects and 1394 nondetects that exceed PRGs.
- **Protactinium-231:** No analyses have been performed in the 200-PO-1 Groundwater OU.
- **Selenium-79:** No analyses have been performed in the 200-PO-1 Groundwater OU.
- **Strontium-90:** 3 wells had exceedances in the last 18 years. 832 analyses from 102 wells resulted in 52 detects and 3 nondetects that exceed PRGs.
- **Technetium-99:** 2 wells had exceedances in the last 18 years. 735 analyses from 146 wells resulted in 13 detects and zero nondetects that exceed PRGs.
- **Tetrachloroethene:** 21 wells had exceedances in the last 18 years. 1,442 analyses from 129 wells resulted in 807 detects and 583 nondetects that exceed PRGs.
- **Thallium:** 4 wells had exceedances in the last 18 years. 542 analyses from 76 wells resulted in 19 detects and 494 nondetects that exceed PRGs.
- **Trichloroethene:** 26 wells had exceedances in the last 18 years. 1,482 analyses from 129 wells resulted in 746 detects and 659 nondetects that exceed PRGs.
- **Tritium:** 92 wells had exceedances in the last 18 years. 4,020 analyses from 183 wells resulted in 2,085 detects and zero nondetects that exceed PRGs.
- **Uranium:** 3 wells had exceedances in the last 18 years. 982 analyses from 122 wells resulted in 29 detects and zero nondetects that exceed PRGs.
- **Uranium-234:** 3 wells had exceedances in the last 18 years. 111 analyses from 29 wells resulted in 4 detects and zero nondetects that exceed PRGs.
- **Uranium-238:** 2 wells had exceedances in the last 18 years. 116 analyses from 29 wells resulted in 5 detects and 3 nondetects that exceed PRGs.
- **Vanadium:** 7 wells had exceedances in the last 18 years. 4,285 analyses from 163 wells resulted in 10 detects and zero nondetects that exceed PRGs.
- **Vinyl chloride:** 3 wells had exceedances in the last 18 years. 1,372 analyses from 120 wells resulted in 4 detects and 1,368 nondetects that exceed PRGs.
- **Zinc:** 2 wells had exceedances in the last 18 years. 4,295 analyses from 167 wells resulted in 2 detects and zero nondetects that exceed PRGs.

The candidate COPCs listed above are the key analytes for further routine evaluation in the groundwater and are listed in Table E1-4.

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